Estimating Soviet Military Hardware Purchases: The "Residual" Approach

A Technical Intelligence Report

SOV 86-10031
June 1986

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Directorate of Intelligence

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A Technical Intelligence Report

This paper was prepared by [redacted] of the Office of Soviet Analysis. Preliminary research on the subject was conducted by [redacted] previously of the Office of Soviet Analysis. Comments and queries are welcome and may be directed to the [redacted], SOVA, [redacted]

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Estimating Soviet Military Hardware Purchases: The "Residual" Approach

Summary

Information available as of 28 April 1986 was used in this paper.

It has long been accepted that the Soviet machine-building and metalworking (MBMW) sector is the source of almost all military hardware—as well as machinery for consumption, investment, and capital repair. When the Soviets report data on MBMW output and on the distribution of this output, however, they do not provide information on the military's share. The secrecy surrounding this information has led many Western analysts to attempt to estimate the share from reported Soviet economic data.

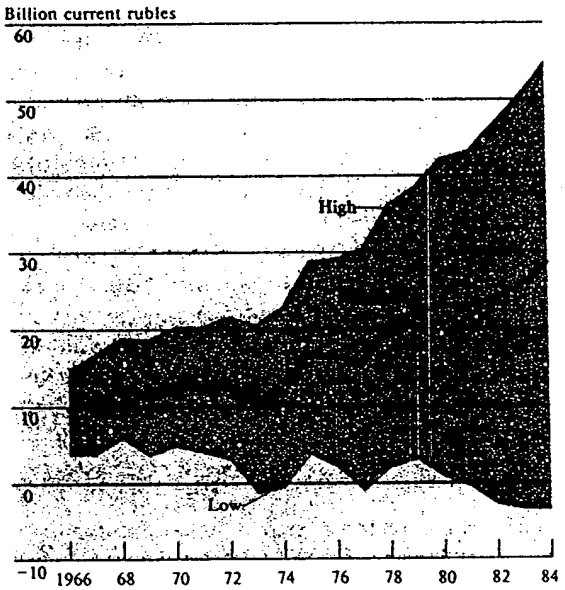
One appealing estimating technique is known as the machinery purchases "residual" approach. The basic assumption of this approach is that all military machinery purchases are included in the MBMW output data, but not in reported purchases. Using this method, analysts subtract the value of identifiable nondefense purchases from the total output of the MBMW sector. The remaining output—the residual—is believed to represent the value of annual military hardware purchases.

We have conducted a lengthy investigation of this approach. In this report, we present the results of our attempt to estimate a machinery purchases residual for the years 1966 through 1984. To derive the estimate, we reviewed the available evidence on MBMW output and the estimating techniques used in previous attempts to apply the residual approach. At each step, we calculated the uncertainties resulting from various interpretations of the data.

Because of the great uncertainties associated with the interpretation of the Soviet data used in the residual procedure, we conclude that the CIA method and two independent methods that were also examined are unreliable as independent techniques for estimating the level and trend of Soviet military hardware expenditures. For example, the estimates for the total value of machinery produced—the starting point for each of the techniques examined—range from 168 billion rubles to 194 billion rubles in 1980.

The data used in the remaining steps in the analysis are incomplete, poorly defined, and incomparable in price base and coverage. To estimate the various categories of nondefense production using these data, for example, many assumptions must be made that, cumulatively, lead to considerable variation in the final estimate. The tremendous range in both the levels and growth rates of residual estimates does not necessarily mean that the

CIA's Residual Estimate of Soviet Military Machinery Purchases



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methods are wrong. But they do illustrate a problem inherent in the approach—that various assumptions and methods used in developing the estimates can cause widely differing results.

The degree of uncertainty in an estimate of military machinery purchases calculated by the residual method becomes readily apparent in an analysis of our results. In current prices they suggest a wide range in estimates of military purchases—between 4 billion and 15 billion rubles of machinery in 1966 and between −4 billion and 55 billion rubles of machinery in 1984. Between those years, the high estimate grew an average of almost 8 percent a year, while the low estimate declined. The "nominal" estimate—for most steps this is the mean—grew approximately 7 percent annually, increasing from 10 billion rubles in 1966 to about 30 billion rubles in 1984. Military machinery purchases measured in 1970 comparable prices—the Soviet version of constant prices, which include considerable inflation—grew

slightly faster than those in current prices; the range of uncertainty was about the same.

Our low estimate of military machinery purchases in current prices actually fell below zero for several years—an intriguing finding since even the low estimate includes not only residual machinery purchases (any that are not specifically accounted for), but also a portion of the reported "civilian" machinery purchases. Therefore, the basic premise of machinery residual analysis—that all military machinery purchases are included in the MBMW data but not in reported purchases—may not be true. In our nominal estimate, a strict accounting of all civilian purchases of MBMW output exhausts the total, and virtually no residual remains. This suggests two possibilities:

- Some or all military purchases are included in MBMW gross value of output (GVO) figures but are not hidden in the data as a residual. Rather, they are distributed among various categories of "civilian" purchases.

- Some or all purchases of military hardware are excluded from data on MBMW GVO as well as from reported purchases of MBMW output.

We are unable to determine which of the hypotheses is true. Because we cannot estimate what portion of military hardware purchases we capture in a residual estimate, the technique has little usefulness as an analytical tool.

Even if we were to obtain better definitions of the content of the Soviet statistics, other problems with the data greatly reduce the value of the results. For example, even when residuals can be estimated, their levels and trends are distorted by hidden inflation in the MBMW sector. Official indexes of comparable prices published by the Soviets understate inflation, leading to an overstatement of growth of real output. As a result, we are unable to distinguish between real and inflationary growth in the Soviet MBMW sector using published statistics.

Very little data have been available on the purchases of machinery—regardless of whether the military or civilian sectors purchase these goods—since 1972. To produce figures for recent years, we must estimate values for many of the key variables. If early benchmark estimates of these values are inaccurate, then extrapolating and using growth indexes and planned growth rates introduce considerable error into the estimates for later years.

Contents

Scope Note

This paper assesses the feasibility of using published economic statistics to estimate the annual value of Soviet military hardware purchases. It is an important part of a broader effort to identify and examine methods that might complement the CIA's intelligence assessments of Soviet defense spending derived using a building-block approach.

Estimating Soviet Military Hardware Purchases: The "Residual" Approach

The Appeal of a Residual

Each year, the USSR publishes data on defense spending in *Narodnoye khozyaystvo SSSR (The National Economy of the USSR*, hereinafter referred to as the *Narkhoz)*. The *Narkhoz* reports annual spending of the Soviet Government in current prices, including a single line item for the defense budget. Since 1969 this figure has been reported within the range of 17-19 billion rubles—a level inconsistent with the known expansion of Soviet military programs and Western estimates of their annual costs.

In addition to the figures reported for defense spending, the *Narkhoz* contains data on industrial production. The subtotals of the various outputs reported for each sector of industry, however, often add to less than the reported total production of that sector. The fact that some output is not specifically accounted for has convinced many Western observers that the production of weapons is hidden in the data.

Several different approaches have been developed to isolate the military items in the data. One of these methods, known as the machinery purchases "residual" approach, separates the reported data on purchases of the output of the machine-building and metalworking (MBMW) sector into purchases intended for military and civilian uses.[1] This method focuses on the MBMW sector because, of the 11 major branches of industry in the Soviet Union, it produces almost all military hardware. Isolating military hardware purchases first requires identifying civilian purchases of machinery and other nondefense production in the published production figures. In theory, the value of machinery allocated to the military—the residual—can be calculated by subtracting the value of all nondefense production from the total.

Estimating military hardware purchases in this manner is appealing because of its apparent simplicity. The approach requires little time and money for research, as it relies almost entirely on published information. Its value depends primarily on whether the necessary pieces of data can be collected, organized properly, and interpreted correctly.

This report describes the complications involved in developing a residual estimate and evaluates the utility of the technique for estimating Soviet outlays for military hardware. It discusses the CIA residual methodology and estimates and compares them with those developed by William T. Lee and the Defense Intelligence Agency (DIA).[2] To assess the contributions that the residual approach can make to research on Soviet military spending, we examine possible sources of uncertainty and their effect on the residual estimates.

The CIA Residual Estimates

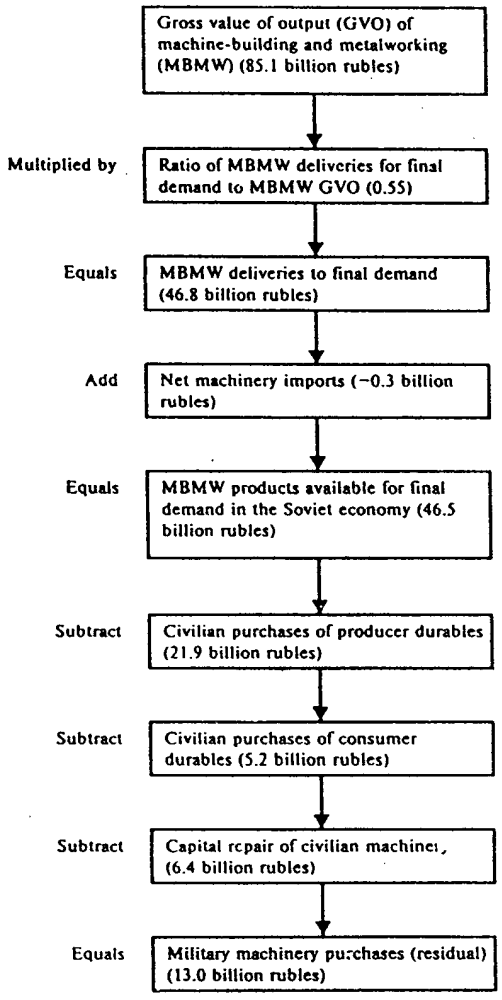
Western efforts to isolate military machinery production by the residual approach date back to the mid-1950s. Many individuals and organizations— including Lee, Robert Campbell, Stanley Cohn, Michael Boretsky, the Rand Corporation, Stanford Research Institute, Wharton Econometrics, DIA, and CIA— have examined published Soviet machinery statistics in an attempt to isolate defense costs. The CIA's residual analysis presented here owes much to prior research. Despite wide differences in detailed calculations and results, we followed the same basic steps as previous methodologies. In some cases, we adopted features of earlier work, with explicit recognition of the uncertainties; in other instances, we relied on our own alternative estimating techniques.

Building an Estimate

Soviet statistics on machinery output do not permit a straightforward determination of a machinery purchases residual. The isolation of military hardware

[1] For this and subsequent footnotes, see page 55.

Figure 1
CIA's Residual Methodology: Nominal Estimate for 1970



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purchases requires several steps that are outlined for a single year in figure 1 and set out in terms of an example in the inset. Because of the numerous adjustments necessary at each step, the process is long and tedious. For this reason, detailed calculations are described in an appendix and explained only generally in this section.

MBMW Output. The estimation of a Soviet military hardware residual starts with the gross value of output (GVO) of the machine-building and metalworking sector, commonly referred to as MBMW GVO. (The glossary explains this and other terms.) The Soviets have reported MBMW GVO—based on slightly lower employment figures than those used in the *Narkhoz*—for several years, which we use as benchmark estimates to check the trend of our estimated series. To estimate annual ruble values for MBMW GVO, we use three different estimating techniques:

- The first method is based on the reported share of MBMW GVO in industry GVO. These statistics are published only for 1975 and 1982, allowing us to estimate output for those years only. Therefore, this method is useful primarily for checking estimates for those years derived by other methods.

- The second method uses frequently published data on the size and wages of the MBMW labor force. From these data and from figures on social insurance deductions and incentive payments, we can calculate total MBMW labor costs. The Soviets publish, as a percentage, the share of labor costs in MBMW production costs, allowing us to calculate the latter. By adding profits to this figure, we derive MBMW GVO. We believe such estimates are fairly accurate; they track closely with the benchmark figures and the values calculated as a share of industry GVO.

- The third method relies on MBMW amortization and capital stock data, which are available for a number of years. The Soviets publish industry amortization charges, from which we can estimate MBMW amortization charges. In addition, the Soviets report the share of amortization charges in production costs, so we are able to determine

MBMW production costs. Then, as in the second method, we add profits to obtain MBMW GVO. This technique produces a complete series of estimates for the years 1966 through 1984. In contrast to estimates provided by the second method, the values from this method are, for some years, slightly lower than the benchmark figures.

The last two techniques produce results that are internally consistent and grow at approximately the same annual rate as the benchmark figures. We range our estimates of MBMW GVO for 1966-84 between the high and low values produced by the two techniques.

MBMW Deliveries to Final Demand. Because our intent is to calculate the value of final goods delivered, all intermediate goods (those delivered to other producing enterprises) produced must be subtracted from the estimate of total machinery output. The Soviets do not report the value of intermediate products or of MBMW output delivered to final consumers (deliveries to final demand). However, we can calculate the ratio of MBMW deliveries to final demand to MBMW GVO for three years using the 1966 and 1972 Soviet input-output tables (as reconstructed in the West) and the preliminary Western construction of a 1977 input-output table.[3] By interpolating and extrapolating, we estimate ratios for the remaining years in the series. Then, we multiply MBMW GVO for each year by the corresponding ratio to get the value of MBMW deliveries to final demand.

Errors in estimating the value of MBMW intermediate products, a substantial portion of total machinery output, can introduce considerable uncertainty into estimates of deliveries to final demand. Moreover, since the Soviets have not released any information on the relationship between GVO and deliveries to final demand since 1972, ratios for later years are simply estimates.

Net Machinery Imports. To estimate the value of machinery available to the Soviet economy, all machinery exports must be subtracted from the value of MBMW deliveries to final demand and all machinery imports must be added—or, more simply, net imports must be added.

Net imports for the MBMW sector are derived from published trade data. Total imports and exports for MBMW industries, as for all industrial branches, are reported each year in the *Narkhoz* as a percentage of total trade. Although these data allow the direct calculation of imports and exports for the MBMW industries, the aggregated import and export data for MBMW and the other industrial sectors do not add to the total in the *Narkhoz*. Seven to 15 percent of Soviet trade is not specifically accounted for. We believe that most of this trade residual is military related, but that not all of that military trade is machinery. Our nominal estimate is that 50 to 90 percent of the unreported exports and 40 to 70 percent of the unreported imports each year involve the transfer of military machinery. The remainder are thought to involve military items such as clothing, food, and medical supplies.

Our estimates of net machinery imports must also be converted from current foreign trade prices to current domestic producers' prices (see glossary). Little information is available on the formation of foreign trade prices, so we must estimate the various conversions for most years.

Up to this point, we have calculated the value of all machinery that is available as a finished product to the domestic Soviet economy. The next steps attempt to separate civilian and military machinery deliveries by subtracting the civilian portion from the total. The first two steps deal with the removal of a major category of machinery—durables—delivered for civilian investment and consumption, and the final step involves the deduction of the value of capital repair work on civilian machinery.[4]

Civilian Purchases of Producer Durables. The estimation of the producer durables (machinery purchased by other production enterprises) component of MBMW deliveries to final demand involves several steps. The estimate consists of three parts:

- The machinery and equipment component of new fixed investment.

Calculating Military Truck Purchases: The "Residual" Approach

To illustrate the reasoning employed at each stage in the residual process, the following example describes how we might determine military purchases of trucks as a residual of the output of a truck factory.

Assume the Soviets have only one truck factory and that they reported the total value of its output, including costs to import and repair trucks, as 100,000 rubles in 1970 (see figure 2). Assume also that the factory produces, in addition to finished trucks, items such as engines that will be shipped to other enterprises for use in their production processes. These items, which may be called intermediate products, are included in the ruble value of output of the truck factory. To estimate only the value of finished trucks delivered by the factory, the intermediate products must be subtracted from the total output. If the published data reported that the intermediate products were 40 percent of total production in 1970, then finished trucks consisted of 60 percent of the total, or 60,000 rubles.

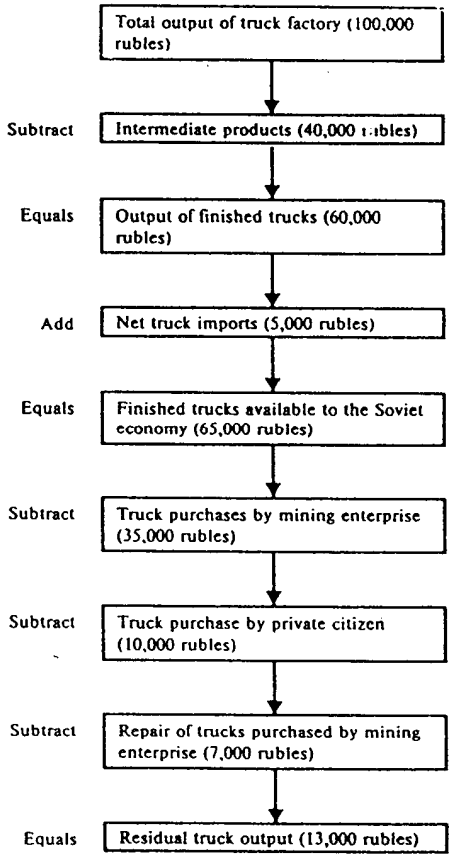
Suppose the factory exported to Poland finished trucks worth 20,000 rubles, while at the same time it imported 25,000 rubles worth of trucks from Hungary. Because imports exceeded exports by 5,000 rubles, the total value of trucks available for sale in the Soviet Union is now 65,000 rubles.

Assume now that the published data reported truck purchases by state enterprises and individuals within the Soviet Union. According to these data, in 1970 a state mining enterprise purchased 35,000 rubles worth of finished trucks from the truck factory as part of its investment in its coal-hauling business. In addition, a private citizen purchased a truck, which cost 10,000 rubles, for his own use. When these two purchases are subtracted from the value of finished trucks available to the Soviet economy (65,000 rubles), 20,000 rubles worth of trucks remain.

But suppose that some of the trucks purchased by the mining enterprise broke down the day after they were purchased, and the mining enterprise returned them to the factory for warranty repair work. Upon inspection, the factory decided the trucks required completely new engines. The cost of the replacements was 7,000 rubles. The factory reported this amount as repair work and as part of overall output. Because this expense is included in the value of final output of the factory, the 7,000 rubles must be deducted, leaving 13,000 rubles. If the Soviets report no additional purchases or repair of these trucks, one could assume that the remaining amount—the residual—represents the trucks purchased by the military.

This example does not deal with the real complexities of residual accounting. In our machinery residual approach—unlike the truck example—we assume that some of the reported purchases of machinery are actually military, and we attempt to separate them from the civilian purchases. In addition, we work on a much larger scale—the entire machine-building and metalworking sector in the Soviet Union—and estimate residual values for each year, 1966 to 1984, in both current prices and comparable (Soviet-style constant) prices. Nevertheless, this example illustrates the basic steps we follow in estimating a military purchases residual and thus provides a basis for understanding the process.

Figure 2
Calculating Military Truck Purchases: The "Residual" Approach



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- Purchases by budget-supported institutions, which consist mostly of schools and government institutions (excluded from new fixed investment statistics since 1964).
- Changes in the stocks of uninstalled equipment at construction sites.

Only the machinery and equipment component of new fixed investment is reported annually. Data for the other two series must be estimated from scattered reports. In addition, the three series are not comparable to the data reported for other machinery uses in terms of the price base and the coverage. The detailed adjustments necessary to make the various data comparable are described in the appendix.

Some defense expenditures may be included in all three parts of the producer durables series. The military purchases many items, known as common-use durables, that are also used in civilian activities. These items, which would be considered part of investment in the civilian sphere, include trucks, cars, cranes, forklifts, transport ships, aircraft, and organizational equipment. We cannot easily divide producer durables into the civilian and military parts, but we estimate that military purchases represent 10 to 20 percent of the value of deliveries of producer durables to final demand. Therefore, to leave the military's portion in the residual, we subtract 80 to 90 percent of the estimated producer durables from MBMW deliveries to final demand.

Civilian Purchases of Consumer Durables. Purchases of consumer durables also must be subtracted from MBMW deliveries to final demand. Consumer durables purchases consist of two parts: private consumption, which includes purchases by individuals for private use, and public consumption, which includes purchases by budget-supported institutions.

The Soviets have published information on private and public consumption of machinery products in 1966 and 1972 in connection with their work on input-output tables. Since they do not report the growth of this consumption, we must estimate values after 1972.

On the basis of our Soviet GNP research, we believe that, by the mid-to-late 1970s, growth in the machinery component of consumer durables had fallen to one-half the rate in 1966-72.

The reported data on consumer durables probably reflect both civilian and military purchases, but their separation is not straightforward. We assume that purchases by military institutions are reflected in statistics on public consumption and calculate them by estimating the value of machinery purchased by military scientific institutions for research and development. These are thought to represent the bulk of all military purchases of consumer durables. To remove only civilian purchases of consumer durables from deliveries to final demand, therefore, we subtract total purchases minus the purchases by military scientific institutions.

Capital Repair of Civilian Machinery. The final step in the deduction of civilian purchases of machinery is the estimation and subtraction of the value of capital repair of civilian machinery from total capital repairs.[5] The Soviets do not publish a value for annual expenditures on capital repair—which includes repair of machinery, buildings, and structures—but we are able to construct a series by combining published data on three major categories of capital repair:

- Amortization of the costs of capital repair.
- Budget expenditures on capital repair of buildings and structures.
- Collective farm expenditures on capital repair.

We know that in 1959, 1970, and 1976, machinery repair accounted for 42 percent, 59 percent, and 54 percent, respectively, of the total. The rest was used for the repair of buildings and structures. By interpolating and extrapolating the percent of total repair allocated to machinery, we derive a series for capital repair of machinery alone.

Military repair may be included in the data, and we follow a DIA technique to separate it from civilian repair. This approach assumes that the ratio of capital repair of military machinery to total capital repair is the same as the ratio of military machinery to total machinery.[6] To calculate this percentage, we subtract all capital repair from MBMW deliveries to final demand—leaving only machinery purchases—and from the residual calculated so far, leaving only military machinery purchases. The ratio of these military purchases to total purchases is multiplied by total capital repair outlays to find the military's share of capital repair. This portion of repair is included in the residual and the civilian portion omitted.

Military Machinery Purchases—the Residual. After civilian purchases of machinery and civilian machinery capital repair are removed, the value remaining represents both an estimate of the military purchases included in reported purchases of producer and consumer durables and capital repair and an estimate of residual—or unreported—machinery purchases. Assuming the data have been correctly interpreted and processed, this value for each year represents military purchases of MBMW output of final products, which we refer to as military machinery purchases.

Results

The methodology decribed above has been used to produce two different residual estimates: one in current prices and one in 1970 comparable prices.[7] Both estimates are calculated for the years 1966 to 1984. Each series includes a range within which we believe the true value of expenditures falls. We also present a "nominal" estimate, which is calculated from the nominal estimate at each step—in most cases, the mean between the high and low estimates. (As explained in the appendix, we do not follow this rule for producer durables and capital repair.)

Estimate in Current Prices. The range of values that results from the application of our methodology is very wide. The cumulative value of the estimates from 1966 to 1984 ranges between 25 billion and almost 600 billion rubles in current prices (see figure 3). The nominal estimate is just over 300 billion rubles. According to this estimate, annual military purchases from MBMW grew from about 10 billion rubles in 1966 to almost 30 billion rubles in 1984. Military purchases grew by almost 8 percent a year from 1966 through the late 1970s but by an average of only 5 to

Figure 3
CIA's Residual Estimate of
Soviet Military Machinery Purchases

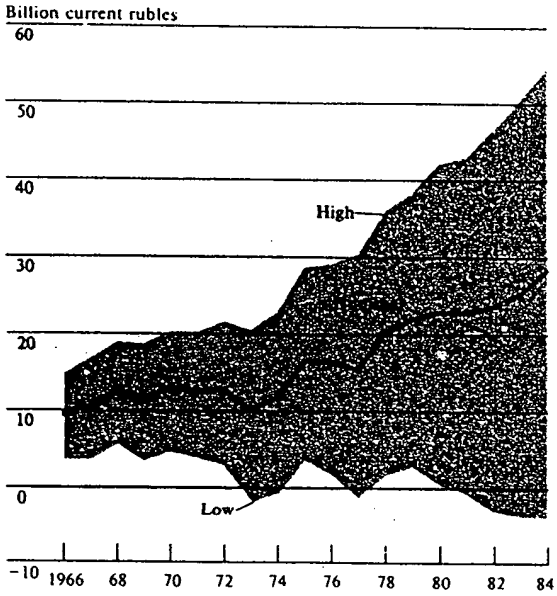
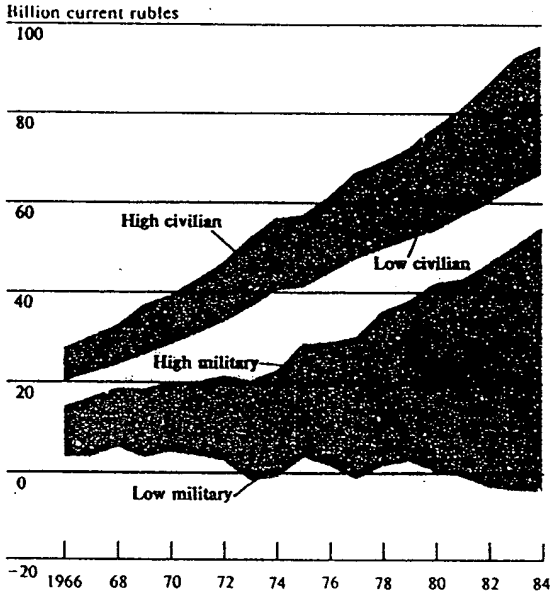


Figure 4
CIA's Residual Estimates of
Soviet Military and Civilian
Machinery Purchases

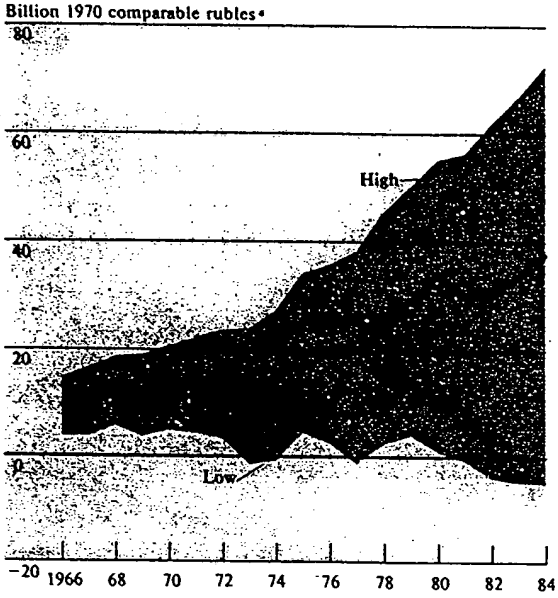


6 percent thereafter.[8] On average, the estimate increased approximately 7 percent annually from 1966 to 1984. Civilian purchases—producer and consumer durables plus capital repair—also averaged about 7 percent annual growth (see figure 4). Each year, civilian purchases were about three times larger than military purchases, indicating that the military purchased a constant one-fourth of the machinery delivered to final demand.

Estimate in Comparable Prices. Our estimate of military machinery purchases in 1970 comparable prices is derived by applying the published MBMW wholesale price index to the current-price estimate. The two series are quite similar except for the growth rate. The published price index suggests a decline in machinery prices, despite all indications to the contrary (see the section on "Current and Comparable Prices"), which causes the comparable-price series to grow faster than the current-price series.

For the 1966-84 period our cumulative estimate in 1970 comparable prices ranges between about 20 billion and 700 billion rubles (see figure 5). Our nominal estimate is almost 400 billion rubles In this series, military machinery purchases were approximately 10 billion rubles in 1966 and climbed to just under 40 billion rubles by 1984. Through 1975 the nominal series grew between 9 and 10 percent per year and, after that, at about 8 percent annually. Over

Figure 5
CIA's Residual Estimate of Soviet Military Machinery Purchases



* Comparable prices represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, reflect considerable inflation.

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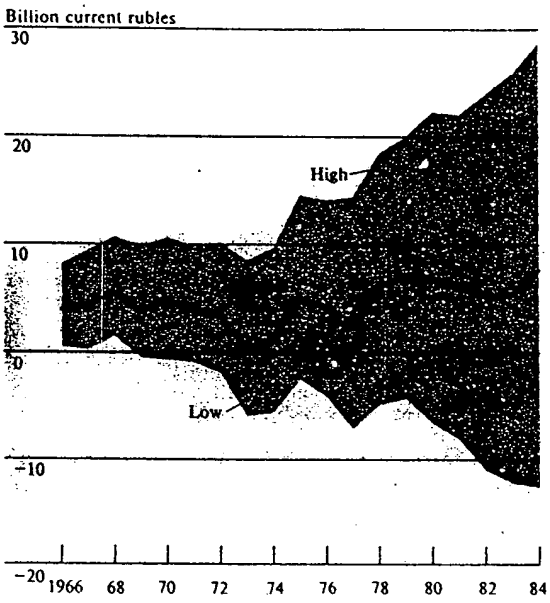
Figure 6
CIA's Estimate of the Pure Soviet Military Machinery Purchases Residual*



* The pure residual is derived by subtracting the reported purchases of producer and consumer durables and capital repair services from the estimate of machinery deliveries to final demand.

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the entire time period, the series increased by an average of almost 9 percent a year.

The "Pure" Residual Estimate. In calculating military machinery purchases as a residual, our low estimate actually fell below zero for several years—an intriguing finding since even the low estimate includes not only residual machinery purchases (any that are not specifically accounted for), but also a portion of the reported "civilian" machinery purchases. We decided to calculate a pure machinery residual, assuming that there were no purchases of military machinery in official figures on new fixed investment, public consumption, and capital repair. We found that under this assumption the residual practically disappears (see figure 6). It ranges from zero to 8 billion rubles in 1966 and from −13 billion to 29 billion rubles in 1984. The nominal estimate suggests the residual was less than 8 billion rubles in 1984, not nearly large enough to cover the level of Soviet military hardware purchases estimated by Western analysts.

Table 1
Soviet Military Machinery Purchases: A Comparison of CIA's, DIA's, and Lee's Residual Methodologies and Results, 1970

	CIA			Lee			DIA		
	Estimate (*billion rubles*)	Methodology	Problems	Estimate (*billion rubles*)	Difference From CIA's Method	Problems	Estimate (*billion rubles*)	Difference From CIA's Method	Problems
Machine-building and metalworking (MBMW) gross value of output	83.9 to 86.4	Uses reported figures and labor force and amortization methods	Data on incentive payments and social insurance incomplete	94.6	Uses labor force method	Double counts incentive payments	86.4	Uses amortization method	Combines data in comparable and current prices
Metalworking and repair				18.7	Deducts all metalworking	Metalworking could be in procurement			
Final demand ratio	0.54 to 0.56	1966, 1972, and 1977 data from input-output tables	Must extrapolate for remaining years	0.600 to 0.620	Uses 1966 ratio for every year	Has not used declining ratios for later years	0.54 to 0.59	Ranges between 1966 and 1972 ratios	Assumes the ratio does not decline
Net machinery imports	−1.0 to 0.5	Includes 50 to 90 percent of export and 40 to 70 percent of import residuals	Contents of overall trade residuals are uncertain	0.8 to 2.4	Does not include any of trade residual	Some of trade residuals may be military goods	0.0	Assumes 70 percent of overall trade residual is machinery	Does not express the uncertainty
Civilian purchases of producer durables	18.6 to 23.9	Includes investment, budget purchases, and change in stock of uninstalled equipment	Only investment data published and military share uncertain	25.3	Assumes all reported purchases are civilian purchases	Some military purchases may be included	21.0 to 21.6	Uses only investment data	Uninstalled equipment and budget purchases are not accounted for
Civilian purchases of consumer durables	4.8 to 5.7	Includes all private and civilian public consumption	Growth rate of consumer durables and military share uncertain	3.9 to 4.0	Includes only private consumption	Some civilian purchases are probably in public consumption	6.6	Includes all private and public consumption	Some military purchases may be in public consumption
Capital repair of civilian machinery	5.1 to 10.0	Uses data on amortization, budget, and *kolkhoz* repair expenditures	Capital repair not annually reported and military share uncertain		Deducts both military and civilian repair	Capital repair may be a procurement cost	5.9 to 6.2	Estimates 30 percent of total capital repair is military	Share may not be constant over time
Military machinery purchases (residual)	4.7 to 20.4	Estimates military purchases of MBMW output	Contents of residual are uncertain	17.8 to 19.5	Interprets residual as defense procurement	Contents of residual are uncertain	12.4 to 17.6	Interprets residual as defense procurement	Contents of residual are uncertain

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Other Residual Methodologies

As noted earlier, the CIA methodology owes much to the research of William Lee and DIA. By including more recent information and reflecting the uncertainties inherent in the estimative process, however, we have developed detailed calculations that differ significantly from Lee's and DIA's. (Table 1 summarizes the differences for a benchmark year, 1970.) These are some of the differences in the coverage claimed for each of the residuals and in the price bases employed:

- DIA and Lee interpret their residuals as total defense procurement. We interpret ours as military purchases of MBMW output, a less comprehensive concept.

- CIA and DIA include military metalworking and repair—two components of MBMW—in the residual, but Lee does not consider them to be defense procurement and subtracts them.

- Lee calculates a series in 1970 comparable prices and DIA derives a series in current prices. We calculate a series in current prices and convert it to 1970 comparable prices using the published MBMW wholesale price index.

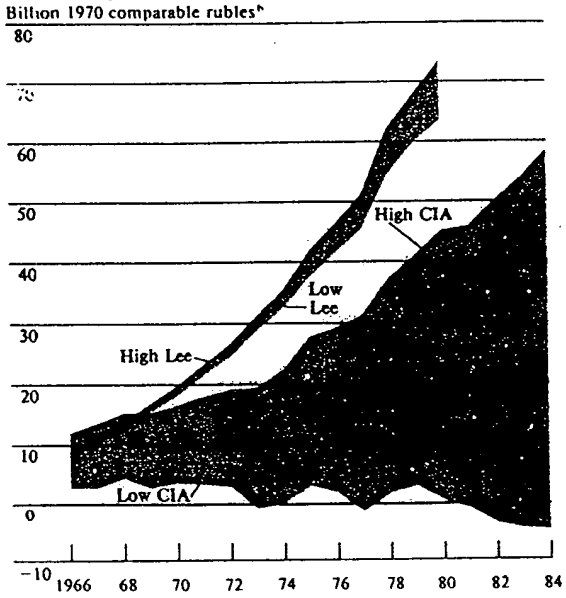
In addition, the three methodologies do not agree on the location of military machinery in MBMW output statistics:

- Lee assumes that reported purchases of machinery (except those for public consumption) are entirely civilian, and the residual military.

- DIA includes both residual machinery purchases and portions of reported purchases of producer durables and capital repair of machinery in its estimate.

- We believe the evidence is not sufficient to determine the location of military purchases in the data. Thus, we calculate both a pure residual and an estimate of military machinery purchases that includes the pure residual and a portion of producer and consumer durables and capital repair. (In the following comparisons, we use the latter estimate.)

Figure 7
Comparison of Lee's and CIA's Residual Estimates of Soviet Military Machinery Purchases[a]



[a] Metalworking and repair were subtracted from the CIA residual to make the coverage comparable to Lee's.

[b] Comparable prices represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, reflect considerable inflation.

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Comparison of Lee's and CIA's Estimates in Comparable Prices

Lee's residual series for 1967-80 in 1970 comparable prices grows at an average annual rate of 16 to 17 percent. CIA's comparable-price series, with metalworking and repair excluded for comparability, increases much more slowly over the same period—the low series declines and the high series grows by about 10 percent annually. The levels of the two residual

estimates also differ significantly. Although Lee's average estimate of military hardware purchases is almost the same as CIA's for 1966, it is three times higher by 1980.[a] Lee estimates that cumulative spending from 1966 to 1980 was about 500 billion rubles, while the CIA's nominal estimate totals less than 200 billion rubles and the high estimate is about 360 billion rubles (see figure 7).

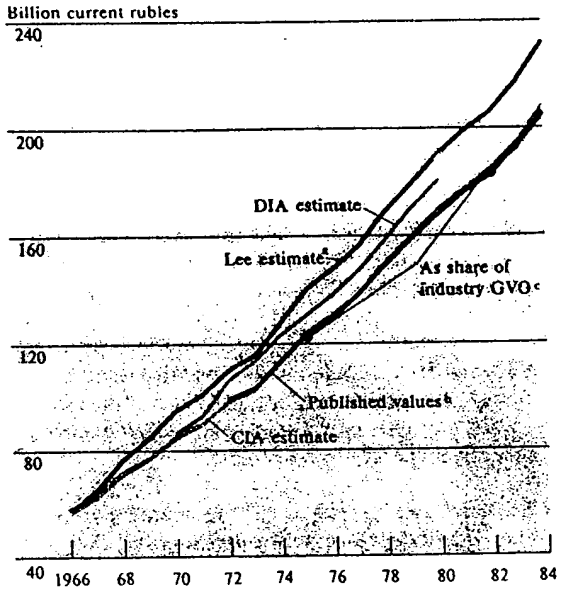
The most notable difference between the two residual series is the uncertainty claimed. From 1966 to 1972 both estimates show fairly narrow confidence bands. For this period, most of the data required for calculating a residual are available. For later years, however, many of the essential parameters had to be estimated. The CIA calculations attempt to convey the uncertainty that is inherent in the estimates because trends in the underlying key variables may have changed since 1972. Lee, in contrast, often assumes growth rates (or values) for these variables have remained constant.

The differences between Lee's and CIA's series have many causes; a discussion of these is contained in the appendix. Three principal sources of differences are the estimates used for total MBMW GVO, the proportion of deliveries to final demand in total GVO, and the size of net machinery imports:

- We believe that Lee overstates MBMW GVO. We have identified a source of apparent double counting in his calculations. Because incentive payments to MBMW workers are paid out of profits, they should be subtracted from wages before calculating MBMW production costs. Lee does not subtract these payments, which leads to an overestimation of GVO by approximately 17 billion rubles per year by 1980 (see figure 8).

- We also believe that Lee underestimates the percentage of MBMW GVO accounted for by intermediate products delivered to other producing enterprises. Although the input-output tables indicate a declining trend in the final demand ratio, Lee assumes it has remained constant. In addition, he has never updated his estimates and still uses a high

Figure 8
Lee's, DIA's, and CIA's Estimates and Published Values of Soviet MBMW GVO



[a] Lee calculates MBMW GVO in 1970 comparable prices. We used his estimating method to calculate a series in current prices.

[b] Values for MBMW GVO in current prices have been reported for 1972-84 by the Soviet Central Statistical Administration in *Vestnik statistiki 1986*, no. 2, and in several United Nation publications. These values correspond to the labor force definition used by the Soviets for United Nations publications and, thus, are calculated from MBMW labor force figures that are about 1 percent less than those reported in the *Narkhoz*. These lower figures result in an estimate of MBMW GVO that is about 1 percent lower than would be calculated using the *Narkhoz* data.

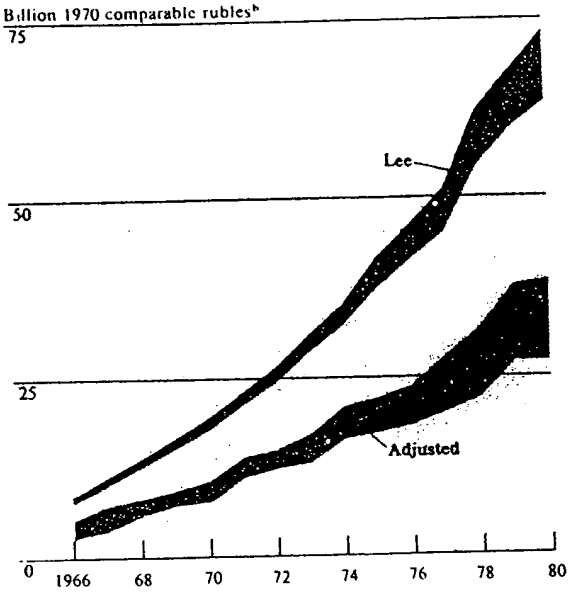
[c] These data points were derived from Soviet published figures on the share of MBMW GVO in industry GVO.

ratio from an early 1966 input-output table for every year in his series. As a result, his estimate of deliveries to final demand is too high.

- Finally, Lee uses official Soviet trade data to calculate net imports through 1975 and then extrapolates for the remaining years by assuming that net machinery imports in 1980 were 2 to 2.8 times larger than in 1975. Subsequent to these calculations, however, trade data were published through 1980 that showed net machinery imports—if calculated the way Lee calculated his pre-1976 estimate—were only 7 billion rubles rather than 8-15 billion rubles, as Lee derived by extrapolation.

Substitution of a revised MBMW GVO, updated net machinery imports data, and the CIA estimates of MBMW deliveries to final demand in Lee's calculations, leaving all of his remaining assumptions unchanged, significantly alters the level and the range of uncertainty of his residual series (see figure 9). Military hardware purchases in the series adjusted by CIA are half the size of Lee's annual estimates. In addition, our adjustments double the range of uncertainty surrounding the estimate.

Figure 9
Lee's Residual and Lee's Residual Adjusted by CIA[a]



[a] CIA derived the adjusted Lee series by substituting its estimates of MBMW GVO, MBMW deliveries to final demand (excluding capital repair) and net machinery imports, leaving all of Lee's other calculations unchanged.

[b] Comparable prices represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, reflect considerable inflation.

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Comparison of DIA's and CIA's Estimates in Current Prices

The consistency between the levels and trends of DIA's and CIA's current-price estimates of military machinery purchases is greater than that between Lee's and CIA's estimates in comparable prices. Nevertheless, there are still many differences. DIA calculates that, during the Ninth and 10th Five-Year Plans (1971-75 and 1976-80), the Soviets spent between 226 billion and 318 billion current rubles on military hardware (see figure 10). Although the CIA's estimate ranges from approximately 20 billion to over 300 billion rubles, its nominal estimate is just under 200 billion rubles.

We estimate that the average annual growth in the current-price residual ranged between −25 and 11 percent from 1970 to 1980, with a nominal estimate of just under 7 percent. DIA, in contrast, estimates that military machinery purchases grew steadily at an annual rate of approximately 9 to 10 percent.

Figure 10
Comparison of DIA's and CIA's Residual Estimates of Soviet Military Machinery Purchases

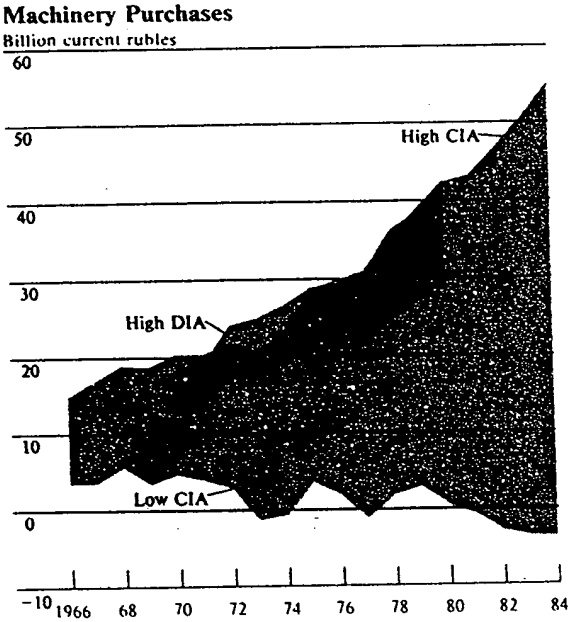

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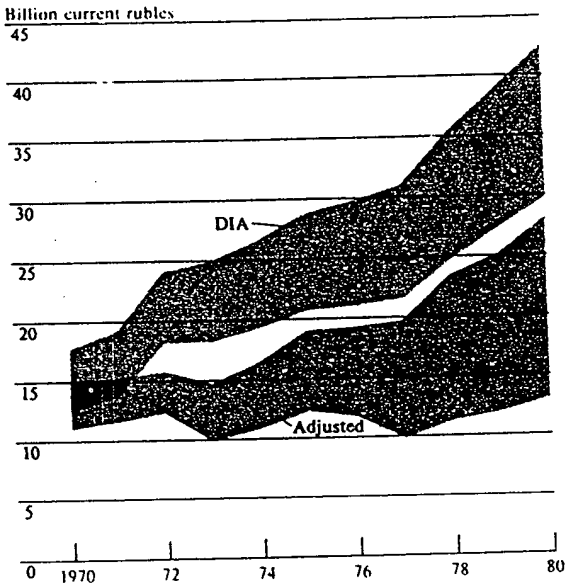
Figure 11
DIA's Residual and DIA's Residual Adjusted by CIA[a]



[a] CIA derived the adjusted DIA series by substituting its estimates of MBMW GVO and MBMW deliveries to final demand, leaving all of DIA's other calculations unchanged.

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Although DIA claims less confidence in the residual than Lee does, it still attaches a range of uncertainty to the estimate that is much narrower than the one CIA calculates. DIA does not substantially widen the range of uncertainty after 1972, even though far fewer of the Soviet building-block data have been published since then.

We believe that DIA, like Lee, overstates the values of MBMW GVO and MBMW deliveries to final demand in its calculations (see figure 8):

- DIA employs amortization data to estimate MBMW GVO, but combines data in current and comparable prices and therefore does not produce a strictly current-price series. Since comparable prices tend to overstate growth compared with data in current prices, we believe that DIA's MBMW GVO estimates are too high.[10]

- DIA assumes that the ratio of MBMW deliveries to final demand to total MBMW GVO remains constant through 1980, even though published statistics indicate the ratio has declined. The result of this assumption is that both the growth rate and the size of deliveries to final demand are overstated for the later years of the estimate.

If CIA's estimates of MBMW GVO and deliveries to final demand are substituted for the corresponding values in DIA's calculations, leaving the remaining assumptions unchanged, DIA's series is changed substantially (see figure 11). For 1980 the adjusted estimate is about 15 billion rubles lower than DIA's original estimate, and the average annual rate of growth of the adjusted series ranges from 2 to 7 percent, rather than 9 to 10 percent. DIA's higher growth rate results from its estimates of higher growth rates for MBMW GVO—caused by using data in comparable prices—and its assumption of a higher ratio of deliveries to final demand to total GVO than that used by CIA.

The Uncertainty of Residual Analysis

The magnitude of the differences between Lee's, DIA's, and CIA's residual methodologies and results and the uncertainty of the estimates are not unexpected outcomes of the attempt to uncover state secrets in Soviet economic data. A clear separation of civilian and military production is prevented by:

- Insufficient and conflicting data.
- Incomparable data.
- Uncertainty about data coverage.
- Uncertainty regarding the basic assumptions of residual analysis.

Insufficient and Conflicting Data

Even if the problem of identifying civilian and military production in the data could be solved, an accurate residual estimate would still be difficult to obtain because of three main shortcomings in the data:

- Some data are available for only a few years.
- Growth indexes and benchmark estimates of uncertain coverage and reliability must often be used.
- Data provided in different sources are often conflicting.

Filling in the data gaps requires many assumptions.

Incomplete Series. Actual data on many of the uses of Soviet machinery output are available for only three benchmark years—1959, 1966, and 1972. Values for the remaining years must be estimated. Most often, the values for 1967-71 are interpolated using the average annual rates of growth calculated from the benchmark figures. After 1972, however, no data points are available to show whether key variables continued to change at the same rate. As a result, the range of uncertainty is extremely wide.

Growth Indexes. Relying on growth indexes rather than actual ruble values to calculate a complete time series of machinery output introduces uncertainty. A ruble value for machinery output must be estimated for a base year and then multiplied by the growth index to obtain a time series. Any inaccuracy in the base figure places the entire series for 1966-84 in error in terms of levels and growth rates. In addition, the derivation of the growth index is often unclear, and we cannot always determine if it represents the same coverage as the benchmark estimate.

Conflicting Sources. Data required to calculate a residual often can be found in more than one source, each of seemingly equal credibility. When we cannot explain the differences, we range the estimates to include all of the information. In other methods, when the estimates are not similarly ranged, we believe the uncertainty of the calculations is understated. Even so, we cannot always be certain we have captured the true values within our ranges of uncertainty because differences in definitions between various sources may distort the trend and level of our estimates. Thus, even the wide range encompassed by our estimate may understate the underlying uncertainty.

Incomparable Data

Soviet economic data frequently are not comparable in terms of the price base and the coverage of the information. Because the information necessary to make the data consistent is not always available, uncertainty is introduced.

We derive residual estimates not only in current and so-called comparable prices, but also on an establishment basis and in producers' prices. The data, however, are not always reported in these prices or

Table 2
Soviet Military Machinery Purchases: Data Available for Residual Analysis

	Comparable or Current Prices	Producers', Purchasers', Estimate, or Foreign Trade Prices	Commodity or Establishment Basis	Data Source
Machine-building and metal-working gross value of output	Current prices	Producers' prices	Establishment basis	*Narkhoz*
Final demand ratio	NA	Producers' prices	Commodity basis	Input-output table
Net machinery imports	Current prices	Foreign trade prices	NA	*Narkhoz*
Machinery producer durables	1969, 1973, and 1984 comparable prices	Estimate and purchasers' prices	Commodity basis	*Narkhoz* and scattered reports
Machinery consumer durables	Current prices	Producers' prices	Commodity basis	Input-output table and CIA GNP data
Machinery capital repair	Current prices	Producers' prices	Establishment basis	*Narkhoz*, state budget, and reports
Military machinery purchases	Goal: current and 1970 comparable prices	Goal: producers' prices	Goal: establishment basis	NA

This table is [redacted]

definitions. (Table 2 summarizes the various types of data available for residual analysis.) We encounter conflicts between:

- Current and comparable prices.
- Establishment- and commodity-based data.
- Producers', purchasers', "estimate," and foreign trade prices. [redacted]

Current and Comparable Prices. In the Soviet Union each product has a comparable price as well as a current price. Just as in open market economies, the current price measures the actual transfer price in any given year. The Soviet concept of comparable prices, however, differs from the Western concept of constant prices. We believe that comparable prices include "disguised" inflation. [redacted]

The primary source of this disguised inflation is the overpricing of new products when they are introduced.[11] In other words, the ratio of the price of the new product to that of the old product is often higher than the differences in the utilities of the two products would support. Overpricing of new products affects the general level of prices used in the derivation of price indexes. The Soviets do not take as the comparable price of new products the price the goods would have received if they had to compete against existing products in the base year in a market in which consumers have free choice. Rather they assign the price at which the good was actually introduced as the comparable price—a price that often reflects high initial unit costs. Thus, an index calculated in so-called comparable prices overstates the growth of real output and understates inflation.[12] [redacted]

The inadequacy of Soviet price indexes as measures of inflation is most apparent in the MBMW sector. The price index for MBMW is biased more than indexes for other branches of Soviet industry because the product list changes more rapidly in the MBMW sector. Enterprises have powerful incentives to push up the prices of new products, because higher prices allow them to meet planned targets for the value of output and, as a result, more bonuses are available. A manager may justify a higher price for a new product

by overstating its technical complexity, by understating the capabilities of goods that would be replaced by the new good, and by overstating the costs necessary to retool the factory to begin production of the new good. In addition, raising the prices of new products by more than is justified by the change in quality allows managers to offset the decline in profits that often occurs because the prices of old products are frozen, even though the costs of inputs increase.

The differences between constant, comparable, and current prices have significant implications for defense spending estimates and our understanding of how these estimates change over time. Since there are no precise measures of Soviet inflation, the differences between the three types of prices cannot easily be interpreted. Conversions from current to constant prices require risky assumptions. Our military residual in comparable prices grows faster than our series in current prices, implying a decline in machinery prices. We believe prices have actually increased, however, mostly as a result of new product pricing. Lee, in contrast, believes that Soviet comparable prices exclude all inflation and are equivalent to the constant prices calculated in market economies. DIA assumes that comparable prices are virtually equivalent to current prices and uses them interchangeably.

Producers', Purchasers', Foreign Trade, and Estimate Prices. The Soviets generally report data in either:

- Producers' prices, which are essentially the prices at the factory gate.
- Purchasers' prices, which include transportation and distribution charges, taxes, and customs duties in addition to producers' prices.
- Foreign trade prices, which are set independently of domestic prices by Soviet planners. Unlike domestic prices, they fluctuate as world market conditions change.
- Estimate prices, which are the supposedly fixed prices used by the Soviets in planning and valuing real investment. These prices include transportation costs.

We chose to calculate a residual in producers' prices because most of the necessary data are reported in these and because they are used by Lee and DIA, facilitating comparisons. Since not all output data are available in producers' prices, we must estimate the conversion coefficients necessary to make them consistent. The information required to derive the coefficients, however, is scarce.

The conversion of purchasers' prices to producers' prices involves the removal and reallocation of taxes and distribution charges. Vladimir Treml, Daniel Gallik, and Barry Kostinsky have developed methodologies for these conversions in their work on changing the 1966, 1972, and 1977 input-output tables from purchasers' prices to producers' prices. We interpolate and extrapolate from their data to derive coefficients for the whole 1966-84 period.

The conversion of estimate prices to producers' prices is less certain. Estimate prices include additional charges similar to those in purchasers' prices. For lack of a better estimate, most residual approaches, including the CIA's, simply apply a coefficient similar to that used to convert purchasers' prices to producers' prices.

Coefficients to convert foreign prices to domestic prices were also estimated for the input-output tables. The coefficients were determined by comparing machinery prices reported in both foreign trade prices and domestic prices. Since the calculation is complex and a limited sample of machinery is available for analysis, the coefficients were estimated for most years and are quite uncertain.

Establishment and Commodity Basis. MBMW GVO calculated from data reported in the *Narkhoz* represents the sum of the ruble values of output of all enterprises that primarily produce machinery and metal articles or repair machinery. Output reported in this manner—that is, on an establishment basis—does not include machinery produced as a secondary product in nonmachinery enterprises of the economy. Furthermore, it includes the nonmachinery output of MBMW enterprises.

Commodity-based data used in input-output analysis, on the other hand, classify items into similar product

groups. Machinery produced outside of MBMW industries is reported with the machinery output of MBMW enterprises, and the nonmachinery output of MBMW enterprises is not included therein. Commodity-based data are preferred for residual analysis because they capture all MBMW output, regardless of where it is produced. Because commodity-based machinery output data are only available for the years of the input-output tables, a complete military residual series cannot easily be calculated. Therefore, we derive an establishment-based residual.

The uncertainty in a commodity-establishment conversion is readily apparent. Originally, we had only one coefficient (0.92), reported by the Soviets for the year 1959, to convert from a commodity to an establishment basis. In the absence of additional data, this coefficient was used by the input-output experts to estimate commodity-based MBMW GVO for an early version of the 1966 input-output table. After publication of this table, actual commodity-based data were obtained and the input-output table was updated.[13] As a result of the update, the 1966 value for MBMW GVO on a commodity basis changed from 54.7 billion to 61.1 billion rubles and the commodity-establishment conversion coefficient changed from 0.92 to a range of 1.06 to 1.09. We have since calculated a coefficient of 1.08 to 1.09 for 1972 by comparing our establishment-based MBMW GVO with the commodity-based MBMW GVO published in the 1972 input-output table.

Some commodity-based data—benchmark estimates of the ratio of MBMW deliveries to final demand to MBMW GVO and estimates for consumer durables—must still be used. We assume that a ratio of final deliveries to GVO on a commodity basis would not differ from one on an establishment basis, and we do not adjust the ratio. We do, however, adjust the consumer durables data to an establishment basis by applying a conversion coefficient of 1.05 to 1.10. This ratio applies to MBMW as a whole (with a range of uncertainty attached), and we do not know whether it applies to the various components of MBMW.

Uncertainty About Data Coverage

A major shortcoming of the machinery residual approach is the inherent uncertainty about the coverage of the final estimate. Some residual analysts consider the MBMW residual to include all defense procurement. We believe, however, that even if the data could be correctly processed, items of procurement that are not produced in the MBMW industries would be excluded from the residual. In addition, because the MBMW data are reported on an establishment basis, they most likely include some nonmachinery items that would not be considered procurement. Thus, we believe that a residual cannot be interpreted strictly as defense procurement.

Although it is difficult to isolate the nonmachinery production of MBMW industries, we can identify possible sources of military procurement not included in MBMW. One source might be the fuel or chemical industries, which produce missile propellants and munitions. Two large possible sources might be the production of "other branches of industry" and the portion of the production total for manufacturing industries that is not specifically accounted for. As reported in the second issue of *Vestnik statistiki 1986*, the GVOs for these two components were 20 billion rubles and 82.6 billion rubles, respectively, in 1984.

Uncertainty Regarding the Basic Assumptions of Residual Analysis

Two assumptions are central to the concept of a machinery residual approach—that reported data on the total output of MBMW include production for both the military and civilian sectors and that data on the purchases of MBMW output for investment, consumption, and repair represent only civilian purchases. The validity of these assumptions cannot be demonstrated, however. In fact, to produce a reasonable estimate of military purchases of machinery, we must assume that some of the reported purchases are military. If we calculate a "pure" residual by assuming that all reported purchases of MBMW output for investment and consumption are for civilian purchases, virtually no residual remains. This suggests two possibilities:

- All or some military production may be excluded from the data on MBMW GVO.

- Some or all military purchases of machinery may be included in MBMW GVO but are not hidden in the data as a residual. Rather, they are distributed throughout the reported data on purchases of MBMW output.

Military Purchases Excluded From the MBMW Output Data. Beyond our discovery that the above assumptions do not allow calculation of a reasonable military machinery residual, we do not have sufficient evidence to conclude that military production is intentionally excluded from Soviet production data. A Soviet emigre, Dmitri Steinberg, has prepared a draft report on Soviet economic balance tables in which he asserts that, contrary to the established view, military production is excluded from data on Soviet production of machinery delivered to final demand.[14] His conclusion is not clearly supported, but it suggests that we may not be able to assume that all defense production is included in the MBMW data.

If this assertion is true, the implications are important:

- Residual analysis cannot be used to estimate military hardware purchases.
- MBMW GVO—including both civilian and military machinery—is higher by an unknown amount than the reported figures.

Military Purchases Included in Reported Purchases. Instead of being totally excluded, some military purchases may be included in the reported Soviet data on purchases of MBMW output—that is, the items usually assumed to be for civilian use and thus subtracted to find the residual. Civilian and military industrial production within the Soviet Union are closely linked. Industries assigned to civilian production are structured to support and augment those assigned to the military, especially during periods of mobilization. For example, factories manufacturing farm tractors have produced military personnel carriers, and civilian machine-building plants have constructed missile launchers.

To obtain our estimate of military purchases of machinery, we assume that some military-related purchases are included in the reported data on ostensibly civilian purchases of MBMW output. In the estimation of producer and consumer durables and capital repair of civilian machinery, therefore, we deduct an estimate of military purchases at each step, as described in the earlier section "Building an Estimate." (Hence they remain in the overall estimate of military purchases—the residual.) Unfortunately, since published Soviet statistics do not contain any information to help us determine the size of these military purchases, residual analysis will not by itself provide accurate estimates of military machinery purchases—the task becomes one of separating civilian and military purchases as well.

Evaluation of Machinery Purchases Residual

In the abstract—as noted in the first section of this paper—the residual approach to estimating purchases of military hardware seems attractive. It relies on information that is openly published, it attempts to reflect the Soviet view of accounting for military and civilian expenditures, and it requires little in terms of time and money for research. In short, minimal effort is required to produce a major estimate. But any procedure used in measuring Soviet defense spending must be judged by the reliability of the estimates it produces.

Because of the many uncertainties inherent in the procedure, we believe residual analysis is unreliable as an independent method for estimating Soviet purchases of military hardware. Soviet economic statistics do not allow a clear identification of either military or civilian machinery purchases. We cannot determine whether military purchases are included in reported purchases for investment, consumption, or other purposes or whether some or all are excluded altogether. Therefore, we do not know whether they are all contained in a residual estimate. Furthermore, we cannot determine what adjustments would be necessary to convert an estimate of military machinery purchases to an estimate of Soviet defense procurement.

Estimates of military machinery purchases themselves are distorted because of hidden inflation in the MBMW sector. Soviet price indexes calculated in comparable prices understate inflation, leading to an overstatement of growth of real output. As a result, we are unable to separate real from inflationary growth in the Soviet MBMW sector using published statistics.

Finally, as the comparisons of our residual estimates with those of Lee and DIA illustrate, the tremendous range in both the levels and growth rates of the estimates severely limits their usefulness as an analytical tool. The conflicting results illustrate a problem inherent in the approach—that differences in the assumptions embodied in residual analysis can cause considerable variation in the estimates. Moreover, very little of the economic data necessary to estimate reported purchases of machinery—setting aside the question of whether they include the military purchases—have been available since 1972. To obtain figures for recent years, analysts must estimate values of deliveries to final demand, net machinery imports, purchases of consumer durables, price changes, and the relationship of commodity basis to establishment basis. If early benchmark estimates of these values are inaccurate, then extrapolating and using growth indexes and planned growth rates introduce considerable error into the estimates for later years. Without new data points, and especially more information on the location of military machinery purchases in Soviet statistics, residual analysis will become increasingly less reliable.

Appendix

CIA Residual Methodology and Results

This appendix traces how the CIA derived its residual-based estimates of Soviet military machinery purchases for the period 1966-84. The final estimates are presented on an establishment basis in both current and 1970 comparable producers' prices.[15] The explanations of the various steps and the corresponding tables are organized in accordance with the sequence of steps outlined in figure 1. The series presented in the tables often include high and low estimates, representing a range within which we believe the true value of expenditures could fall. The notes accompanying each table describe the details of the calculations and/or identify the sources for each row in the table.

In addition to setting out our methodology and calculations, we describe at each step the general approach taken by DIA and William Lee. We outline briefly how their interpretations of the data and their assumptions differ from ours and, at the end, include tables illustrating our interpretation of their calculations.

MBMW GVO

The MBMW GVO series with which we begin the calculation of Soviet military machinery purchases is not reported by the Soviets on an annual basis. Establishment-based figures in current prices can be calculated directly for 1975 and 1982. The Soviets have reported MBMW GVO—based on slightly lower employment figures than those used in the *Narkhoz*—for some years, which we use as benchmark estimates to check the trend of our estimated series.[16] There are several ways of calculating MBMW GVO. The first of the two methods that we prefer relies on reported labor force and wage data (see figure 12). The calculations (presented in table 3, page 32) are relatively straightforward:

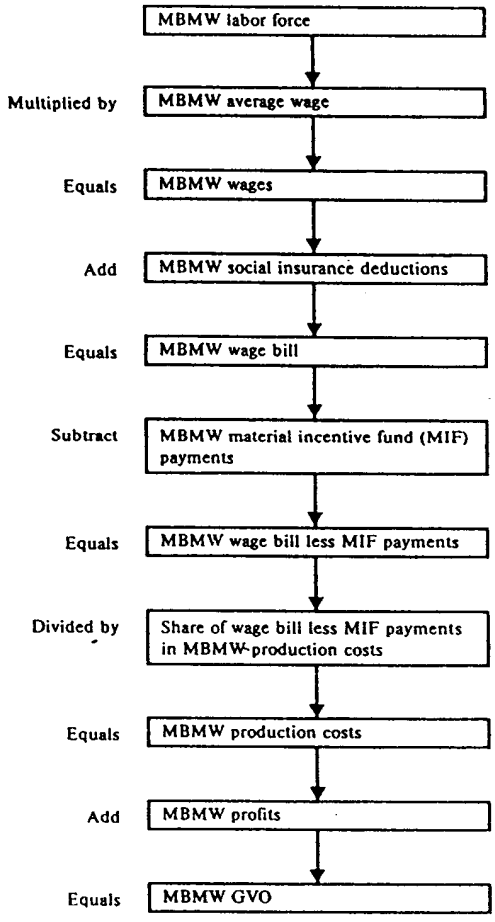
- Multiply the MBMW average wage by the number of employees in the MBMW labor force to obtain total MBMW wages.
- Add social insurance deductions for MBMW workers to the wages to calculate the wage bill.
- Subtract material incentive fund (MIF) payments from the wage bill. These payments, although reported as wages, are actually paid out of profits and must be subtracted.
- Divide the MBMW wage bill, less MIF payments, by the reported share of these costs in production costs to obtain total MBMW production costs.
- Add MBMW profits to production costs to arrive at MBMW GVO.This method produces estimates of MBMW GVO for 1966-84 in current prices.

All of the necessary information for the labor force and wage method except the value of social insurance deductions and MIF payments is reported or can be reliably estimated. The major uncertainty in the calculation of MBMW GVO relates to the accuracy of our estimates of those values. A small difference in their values results in a large change in MBMW GVO.

We do not know the social insurance rate for 1966 and 1967. In 1968 the Soviets reported deductions ranging from 6.6 to 7.7 percent of wages for various branches of MBMW. We estimate an average rate for all MBMW as approximately 7.2 percent of the wage bill by weighting each of the reported rates with the estimated number of employees in that branch. We use that rate for 1966-81; in 1982 the Soviets raised the social insurance rate for MBMW to 14 percent of wages.

Estimates of the MIF payments are less certain. These payments have been reported annually for all of industry since their introduction in 1966, but only scattered information has been released for individual branches of industry. The Soviets have reported that MBMW employs a larger portion of engineering and technical workers than does industry as a whole and

Figure 12
CIA's Method of Estimating MBMW GVO From Labor Force Statistics



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that these employees receive much larger MIF payments than do production workers.[17] In 1973, MIF payments in the MBMW Ministry of Instrument Making, Automation Equipment, and Control Systems—a ministry that presumably had a high proportion of engineering and technical workers—were 15.6 percent of wages. In the Ministry of the Machine Tool and Tool-Building Industry, a less sophisticated industry, MIF payments were 8.2 percent of wages, the same as in all industry for that year. We believe that, on average, MIF payments as a percent of MBMW wages are at least equal to those for industry, and are probably much higher. We estimate the annual ratio of MBMW MIF payments to wages in MBMW as 1.50 to 1.75 times the industry ratio, which can be calculated from regularly published data. (

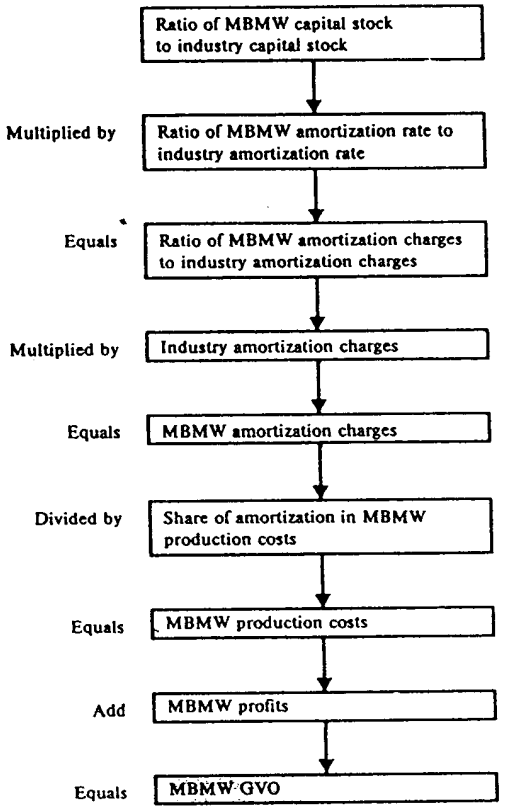
This technique produces estimates of MBMW GVO that are consistent with the values of 122.7 billion and 183.3 billion rubles calculated as a share of industry GVO for 1975 and 1982, respectively, and with the benchmark figures from United Nations publications. These latter figures are up to 2 percent lower for most years than the nominal estimates calculated from the labor force and wage data.[18]

The size and even the existence of the MBMW MIF payments have been a point of controversy in the calculation of MBMW GVO. Lee also uses the labor force and wage method but does not subtract MIF payments. We believe this omission results in an overstatement of MBMW GVO. Aside from explicit statements in Soviet sources about the cost-structure tables,[19] the necessity of removing these payments can be shown by using the labor force and wage approach to calculate GVO for industry—values which are published annually in current prices. The calculated GVO figures are within 1 percent of the published values for every year from 1966 to 1984. If the MIF payments are not subtracted, the figures are approximately 7 percent higher each year, which amounted to about 60 billion rubles in 1984

Our second technique for estimating MBMW GVO is based on amortization data (see figure 13). The following are the main estimating steps (see table 4):

- The Soviets report the ratio of MBMW capital stock to industry capital stock and the ratio of the

Figure 13
CIA's Method of Estimating MBMW GVO From Amortization Data



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MBMW amortization rate to the industry amortization rate. Since capital stock times the corresponding amortization rate equals amortization charges, these two ratios can be multiplied to find the ratio of MBMW amortization charges to industry amortization charges.

- Multiply the ratio calculated above by annual industry amortization charges to calculate MBMW amortization charges.
- Divide the MBMW amortization charges by the share of amortization in production costs to calculate MBMW production costs.
- Add MBMW profits to MBMW production costs to arrive at MBMW GVO. (redacted)

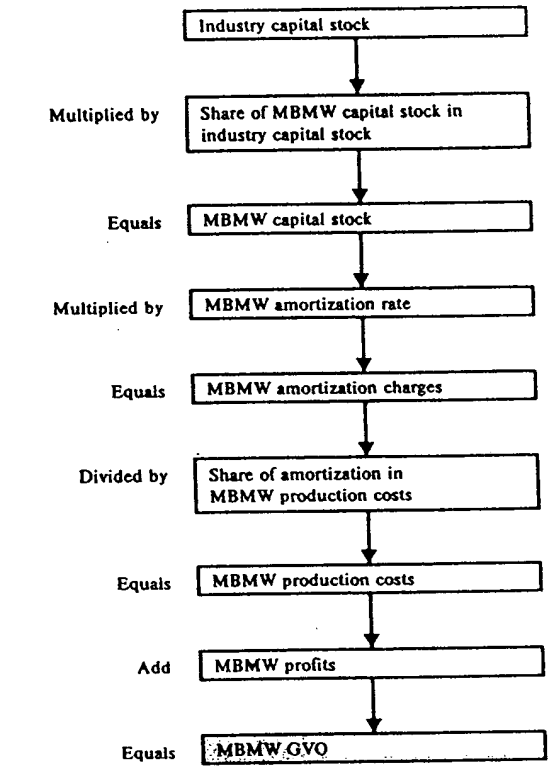
The only data not annually reported are the MBMW amortization rates. Actual rates, however, are not crucial to the accuracy of the estimate because the ratio of the MBMW amortization rates to the industry amortization rates, which remains fairly consistent over time, can be employed. For 1966-77 the ratios are known. We use the 1977 ratio for the remaining years. (redacted)

Our estimates of MBMW GVO calculated by the amortization method are also similar to those which can be calculated directly for 1975 and 1982 and to the benchmark figures. But in contrast to the values calculated from the labor force method, these figures are, for some years, slightly lower than the benchmark values. Since our estimates from the two techniques are internally consistent and grow at approximately the same annual rate as the benchmark figures, our annual estimates of MBMW GVO are ranged between the two series (see table 5). (redacted)

DIA also employs amortization data to calculate MBMW GVO, using a different method (see figure 14). We believe its approach does not take into account the following problems:

- DIA does not use a consistent price base. The Soviets report industry capital stock in current prices only for 1973 and 1974; for other years they report the data in 1955 or 1973 comparable prices. DIA does not adjust the prices.

Figure 14
DIA's Method of Estimating MBMW GVO From Amortization Data



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- DIA does not allow for uncertainty even though the Soviets stopped publishing MBMW amortization rates in 1978. Minor differences in estimates for subsequent years would significantly affect the MBMW GVO series. For example, changing the rate by only 0.003 alters the annual MBMW GVO estimate by approximately 6 billion rubles.

MBMW Deliveries to Final Demand

The reported gross value of MBMW output includes not only the value of final goods produced in MBMW—those going to investment, exports, public and private consumption, and (presumably) defense—but also the value of goods used in the production of machinery and other products. These intermediate products must be subtracted from MBMW GVO to obtain MBMW deliveries to final demand.

The accuracy of the residual series depends largely on the accuracy of the estimate of deliveries to intermediate uses, since it is such a large share of total machinery output. The Soviets, however, publish little information on the relationship between output of intermediate and final products. We estimate the value of the deliveries to final demand by multiplying total machinery output (MBMW GVO) by the ratio of those deliveries to total output (the final demand ratio). (See table 6.) The CIA's final demand ratios are derived from data published in the reconstructed 1959, 1966, and 1972 input-output tables and in a preliminary Western construction of a 1977 table. These ratios show a downward trend over time.[20] We interpolate between the 1966 and 1972 input-output benchmark ratios to estimate a series for the years in between. After 1972 the appropriate trend in the ratios is less certain. Since the estimated 1977 final demand ratio of 0.52 may not be as reliable as the earlier ratios, we range it from 0.50 to 0.54. We then estimate ratios for 1973-77 by interpolation. After 1977 we have no information at all, and thus the trend becomes much more uncertain. We estimate low ratios for 1978-84 by extrapolating the trend established for 1972-77; for the high ratios we hold the 1977 ratio constant.

Although the input-output tables indicate a declining trend in the final demand ratio, Lee and DIA assume that it has remained constant since 1966.[21] Lee has never updated his estimates and still uses a high ratio from an early version of the reconstructed 1966 input-output table for every year in his series.[22] His low and high ratios, respectively, include and exclude the cable industry, which had negative final demand in an

early reconstruction of the 1966 input-output table. DIA applies the 1966 and 1972 ratios, in a range of 0.54 to 0.59, to every year from 1970 to 1980.

Net Machinery Imports

After MBMW deliveries to final demand have been determined, the total value of machinery available for domestic use can be calculated by adding net machinery imports. The annual Soviet statistical handbooks report trade in machinery and equipment in current foreign trade prices. Soviet statistics on trade by category also contain large unexplained residual elements. About 5 to 7 percent of total imports and about 14 to 16 percent of total exports are not accounted for each year.

We believe that most of the unidentified trade is military related, although some of the goods may be materials such as clothing, food, and medical supplies.[23] We estimate that 50 to 90 percent of the export and 40 to 70 percent of the import residuals reflect military-related machinery trade. The CIA's low estimates of net machinery imports include the explicitly reported imports of machinery and equipment and 40 percent of the import residual less the explicitly reported exports of machinery and equipment and 50 percent of the export residual. The high estimates include the explicitly reported imports and 70 percent of the import residuals less the explicitly reported exports and 90 percent of the export residuals. (Table 7 presents the estimating steps.)

The export data reported in the *Narkhoz* may represent machinery produced during the previous year. To provide consistency between production and the reporting of machinery as exports, we include a six-month to one-year timelag in our estimate of machinery exports, on the basis of research by Philip Hanson.[24]

Some machinery imports may be delivered to producing enterprises and thus would be considered intermediate products rather than deliveries to final demand in the Soviet economy. The one data point we have suggests that 15 percent of imports went to the production enterprises in approximately 1976. We do not know if this rate has changed over time. Because of the uncertainty, we reduce our annual estimate of total imports by 12 to 18 percent.

Conversion of net imports to domestic prices is necessary to provide consistency with the other data used in the residual calculations.[25] The conversion from current foreign trade prices to current domestic producers' prices requires two steps:

- Conversion from current foreign trade prices to current domestic purchasers' prices.
- Conversion from current purchasers' prices to current producers' prices.

The CIA's foreign-to-domestic price adjustments rely on input-output conversions of machinery trade data from foreign to domestic prices by Treml and Kostinsky. They calculated ratios of 0.71 for foreign prices to domestic prices for both imports and exports in 1966, and 0.978 for imports and 0.92 for exports in 1972. In addition, they have preliminary estimates of 1.00 for both imports and exports in 1982. Since the derivation of these coefficients is complex and based on a limited sample of machinery, the CIA ranges each coefficient plus or minus 0.02 to allow for possible error. Coefficients for the remaining years are calculated by interpolating and extrapolating.

The next step, adjusting to producers' prices, uses the MBMW GVO conversion coefficients calculated from the 1966, 1972, and 1977 input-output tables. The coefficients—0.92 in 1966, 0.91 in 1972, and 0.89 in 1977—show a downward trend. Given the error introduced by commodity-based input-output data and the limited information on the conversions, we range each of the coefficients plus or minus 0.02. Estimates for remaining years are interpolated and extrapolated.

Although the calculation of net machinery imports seems straightforward, not all residual methodologies agree on the steps. Lee includes only the explicitly reported machinery imports and exports in his machinery trade estimates and, therefore, includes none of the residual. DIA, in contrast, assumes that 70

percent of the overall residual consists of military-related machinery (compared with the 40 to 70 percent of imports and 50 to 90 percent of exports that we include).

In addition, Lee moves his series to current domestic prices but not to producers' prices and 1970 comparable prices. DIA's price adjustments differ from those of CIA at two steps. DIA uses only the 1972 Treml and Kostinsky foreign-to-domestic conversion coefficients. It applies a constant coefficient of 0.95, rather than a decreasing coefficient, to convert from purchasers' to producers' prices.

Civilian Purchases of Producer Durables

Next, civilian machinery purchases must be subtracted from domestic MBMW deliveries to domestic final demand to isolate what is presumed to be military goods. One component of reported purchases is producer durables. The CIA estimate of these durables (calculated in table 8) is the sum of three parts:

- The machinery and equipment component of capital investment.
- Equipment purchased by budget-supported institutions. (Institutions in this category, unlike self-supporting *khozraschet* enterprises, receive their funding for current expenses from the state budget.)
- Changes in the stocks of uninstalled equipment at construction sites.

Data on the machinery and equipment component of capital investment, published annually in estimate prices in the *Narkhoz*, account for the largest portion of machinery producer durables. Western analysts generally agree that these statistics reflect machinery investment six months or a year after production. Therefore, the investment data reported for a given year are assumed to represent production six months to one year earlier. The low estimate for producer durables is calculated by averaging the data for the given year and the following year, while the high estimate for each year is the reported investment in the following year. (We use a one-year timelag for our nominal estimate.)

The machinery and equipment component of capital investment was reported in the *Narkhoz* in 1955 comparable prices for 1966-68, in 1969 comparable prices for 1969-72, in 1973 comparable prices for 1973-83, and in 1984 comparable prices for 1984. We assume that investment prices did not change between the price reforms that resulted in these price base changes. Thus, our current-price series represents the comparable price in effect for that year.[26]

In addition, the reported data on capital investment probably include some nonmachinery goods. Using Michael Boretsky's work, we estimate that 5 to 10 percent of the total is composed of nonmachinery products.[27] By applying this deduction, our estimate is reduced by 10 percent for the low estimate and 5 percent for the high estimate.

To derive a time series of purchases by budget-supported institutions for 1966-84, we extrapolate from benchmark data points for 1960-64 and 1976-80. The 1964 *Narkhoz* reports acquisitions of equipment by budget-supported institutions in the reported machinery and equipment component of capital investment for the years 1960-64—years which lie outside our period of investigation. Subsequent yearbooks do not include these statistics with the investment data. Benchmark values for 1960-64 can be calculated by subtracting the investment data in the 1965 *Narkhoz* investment data (which exclude the equipment purchases) for those five years from the yearbook's data for 1964 (which include the equipment purchases) for the same years. We also know from published budget data that these outlays made up 1 percent of total union-republic budgets from 1976-80, allowing us to derive a series for those years. We range the estimates to allow for uncertainty.

The Soviets have published only scattered data on changes in the stocks of uninstalled equipment at construction sites. The CIA calculations of Soviet GNP include estimates of the annual changes in the stocks based on these scattered reports. We use that

series and interpolate and extrapolate where necessary. Since the various reports may differ in terms of price and coverage, the estimates are ranged to express our uncertainty.

The above three series are summed to obtain total producer durables. An additional step is necessary to move this series to current producers' prices. The MBMW component of investment is reported in estimate prices and the remaining data are in purchasers' prices. We use the same conversion coefficient to move both types of prices to producers' prices. Our coefficient again relies on Boretsky's research. He estimates that 5 percent of the total value reported for the machinery and equipment component of capital investment should be deducted to remove the transportation charges and convert to producers' prices. We apply this rate to all machinery producer durables.

At this point the calculated series represents the machinery component of producer durables in current producers' prices, but we assume these data include substantial amounts of defense hardware in the form of common-use durables. These include items such as trucks, cranes, cars, organizational equipment, transport aircraft, and auxiliary naval ships, which are predominately used by the civilian sector. Only civilian purchases of producer durables should be deducted from MBMW final demand so that the military portion remains in the residual. We estimate that 10 to 20 percent of total machinery producer durables are purchased by the military.

Lee uses the same three series to estimate producer durables, but some of his calculations differ from those employed by the CIA:

- He does not allow for a lag between the production of machinery and the reporting of it as investment.
- He does not remove the value of nonmachinery products that may be included in investment data.
- He assumes that all reported purchases of machinery producer durables represent civilian purchases.

DIA's producer durables series includes only the capital investment data reported in the *Narkhoz*. The conversion of the data from estimate to producers' prices is accomplished by deducting 5 percent for transportation charges and 5 percent for the non-MBMW goods that might be included in the reported values. DIA assumes, as we do, that prices did not change between the periodic price reforms affecting machinery and construction prices. DIA also believes that military procurement of common-use durables may be reported under producer durables. To account for this possibility, it adds to the residual what it considers to be a conservative estimate of military common-use durables. For example, DIA's estimate of these is 0.4-1.0 billion rubles for 1970; our estimate is 2.7-4.6 billion rubles.

Civilian Purchases of Consumer Durables

Consumer durables form the second component of reported purchases of MBMW output. The CIA consumer durables series, which includes durables for both private and public consumption, is based on data published in the 1966 and 1972 input-output tables. (Table 9 shows the calculations.) First, the figures are converted to an establishment basis by applying a commodity-establishment coefficient range of 1.05 to 1.10—similar to that calculated for MBMW GVO. We estimate consumer durable values in current prices for 1967-71 by interpolating. Little information is available on the growth of consumer durables after 1972. From our research on Soviet GNP, we believe that annual growth in consumption dropped after 1972 to about one-half of the pre-1972 rate in constant prices. To estimate the consumer durables series in current prices after 1972, we gradually lower the growth rate—allowing for uncertainty—to one-half that suggested by the 1966 and 1972 data.

Purchases of consumer durables may include purchases by both the military and civilian sectors. We believe that since private consumption represents purchases by individuals, rather than organizations, military purchases would not be included. Public consumption, however, could include hardware purchases by military schools and hospitals, the administration of the Ministry of Defense, and institutes engaged in military research and development (R&D). If this is

true, we need to separate the military purchases from total public consumption so they remain in our estimate of military machinery purchases. (

We have developed a technique for estimating what we consider to be a major portion of the military purchases of public consumption. R&D purchases, which probably include both civilian and military machinery, are reported as part of material inputs to science. The MBMW industries provided 43 percent of these material inputs in 1970, less amortization.[28] Because of the increasing complexity of R&D, we believe that the MBMW share of material inputs has increased since 1970. In the calculations, we increased the share 1 percentage point each year. We assume that military purchases are included in the machinery component of material inputs to science and estimate that the military share of these purchases could be as low as 50 percent or as high as 75 percent. Our estimates of civilian purchases of consumer durables represent total consumer durables less these estimates of military purchases of machinery for R&D.[29]

Lee's calculation of consumer durables differs considerably from that of the CIA. He deducts only private consumption, reasoning that public consumption consists only of military purchases. He derives his 1966-69 estimates from data reported in the *Narkhoz* and converts to an establishment basis with the reported ratios of 0.92 and 0.88 in 1959 and 1966, respectively, and interpolates figures for the intervening years. For the period 1970-80, he derives a consumer durables series from *Narkhoz* data on the share of machinery consumer goods in gross value of output.

DIA assumes that no military purchases are included in the reported consumption data and, therefore, includes all private and public consumption in its consumer durables series. The data are taken from the 1972 input-output table and expanded to a time series for 1970-80 by applying an index of machinery consumer goods—based on the same data Lee used—calculated from data in the *Narkhoz*. The growth index measures gross value of output, but DIA uses it as a proxy for final consumption. In addition, some of the machinery output originally used to derive the index is purchased by production enterprises and thus is considered producer durables rather than consumer durables.

Capital Repair of Civilian Machinery

The Soviets do not publish annual values for expenditures on capital repair of machinery.[30] There have been efforts to construct a time series by aggregating published statistics on three major categories of capital repair. Although these data are not entirely homogenous in definition, they seem to capture reasonably well the overall trend and level of expenditures on total capital repair—repair of buildings and structures in addition to the repair of machinery.[31] We can estimate machinery capital repair because we know for some years the percent of total capital repair it represented.

We use information derived in an unpublished working paper to estimate capital repair.[32] (See table 10 for the calculations.) He developed a series for total capital repair measured in current prices, in which he included:

- Amortization deductions for capital repair.
- Budget expenditures on capital repair of buildings and structures.
- Collective farm expenditures on capital repair.

Amortization deductions do not represent actual expenditures on capital repair, but rather are funds set aside in line with the Soviet practice of levying an amortization charge on plant and equipment to finance periodic capital repair. In any given period of time the amount set aside for capital repair may be higher or lower than the amount actually spent for the repairs. The planned expenditures were, on average, slightly higher than actual expenditures in 1951-62.[33] We assume that amortization deductions for 1966-84 follow this pattern, and we calculate low capital repair estimates by multiplying reported amortization deductions by 0.85 and assign the reported figures as the high estimates. (

Budget expenditures on repair of buildings and structures are reported for union-republics in the Soviet budget handbooks for 1966-80. We extrapolate values for the remaining years. We range the figures to express our uncertainty.

The final component in our estimate of capital repair is *kolkhoz* (collective farm) expenditures on capital repair. has calculated a time series based on data collected from published Soviet literature for 16 years scattered between 1951 and 1975. Since no subsequent data have been released, he assumes that the average annual growth rate of 8 percent for 1970-75 continues. We extrapolate through 1984, ranging the growth rate from 7.8 to 8.2 percent each year to allow for uncertainty.

The repair of buildings and structures must be removed from these three components of total capital repair to calculate capital repair of machinery. In 1959, 57 percent of total capital repair was allocated to buildings and structures while 43 percent was allocated to machinery. In 1970 the share was 41 percent for buildings and structures and 59 percent for machinery, the reversal in shares being due to the revaluation of capital stock. By 1976 the buildings and structures share had risen to 46 percent while the machinery share had dropped to 54 percent.[34] To develop a time series, we range each reported figure plus or minus 2 percent and interpolate and extrapolate for the remaining years.

The machinery capital repair estimates may include some military purchases. No data have been published by the Soviets on the allocation of repair between the civilian and military sectors. We employ an estimating technique derived by DIA. The ratio of military capital repair to total capital repair may correspond to the ratio of military machinery purchases to MBMW deliveries to final demand.[35] Thus, we apply the ratio of military machinery purchases (the residual so far) to MBMW deliveries to final demand, both exclusive of capital repair. The military share is 10 to 40 percent in 1966 and zero to 50 percent in 1984.

Lee does not include any values for repair in his residual.[36] He considers the repair of weapon systems to be an operating cost rather than procurement and thus excludes repair from his estimate of military hardware procurement. To calculate repair for 1966-75, Lee multiplies the 1966 repair values from the input-output table by a repair growth index published in the *Narkhoz*. We believe an estimation of repair in 1970 prices also requires converting the data from commodity to establishment basis and from 1966 to 1970 comparable prices, but Lee does not make these adjustments.

Like CIA, DIA retains military capital repair in the residual. To estimate a repair series, DIA begins with a capital repair value of 10.3 billion current rubles in 1972 from that year's input-output table. DIA constructs two growth indexes to approximate the value of MBMW capital repair in earlier and later years. The first index relies on published amortization deductions for Soviet industry; the second is interpolated and extrapolated from the 1966 and 1972 input-output values. Finally, DIA calculates the value of capital repair assumed to represent civilian purchases. To calculate the military share, it uses the ratio of the MBMW residual to MBMW deliveries to final demand, both exclusive of repair. From this method, DIA estimates that the military consumes 30 percent of total capital repair.

Machinery Purchases Residual

After the civilian purchases of machinery—producer durables, consumer durables, and capital repair—have been removed from machinery deliveries to final demand, the remaining output—both that not accounted for in reported purchases (the pure residual) and that portion estimated to be the military's share of reported purchases of machinery—is assumed to represent military purchases of MBMW output in current prices. (See table 11 for the final calculations.)

We convert the series to 1970 comparable prices. The Soviets publish a price index for MBMW GVO, but not for its various components. We initially attempted to calculate a 1970 comparable-price estimate at each step of the calculations, but soon found that comparable-price data are only available for producer durables. Thus, we assume that the price index for military machinery is the same as that for MBMW GVO. We doubt the validity of this assumption and use it solely for the purpose of comparing our results with Lee's findings.

We also estimate a pure machinery residual (see table 12). For this purpose, we assume that all reported purchases of machinery represent civilian purchases and, therefore, that all military purchases are not accounted for and are included in the residual.

To allow a comparison of our results with those of Lee and DIA, we provide an interpretation of their residual calculations in tables 13 and 14.

Appendix Tables

As described on page 21, the following tables present detailed calculations for estimating military machinery purchases.

Table 3
Soviet Machine Building and Metalworking:
Gross Value of Output From Labor Force Data

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Labor force (*million workers*) [a]	10.40	10.85	11.28	11.70	12.02	12.37	12.72	13.05	13.42
(2) Average wage (*thousand rubles*) [b]	1.28	1.35	1.48	1.55	1.61	1.67	1.72	1.78	1.89
(3) Machine-building and metalworking (MBMW) wages [c]	13.29	14.68	16.66	18.11	19.39	20.68	21.90	23.29	25.30
(4) MBMW social insurance [d]	0.96	1.06	1.20	1.30	1.40	1.49	1.58	1.68	1.82
(5) MBMW wage bill [e]	14.25	15.74	17.86	19.42	20.78	22.17	23.48	24.96	27.12
(6) MBMW material incentive fund (MIF) payments [f]	0 0	0 0	1.03 1.17	1.80 2.03	2.22 2.51	2.50 2.82	2.72 3.07	3.00 3.38	3.29 3.72
(7) MBMW wage bill less MIF payments [g]	14.25 14.25	15.74 15.74	16.70 16.83	17.39 17.62	18.27 18.56	19.34 19.67	20.41 20.76	21.58 21.97	23.40 23.83
(8) Ratio of wage bill less MIF payments to MBMW production costs [h]	0.283	0.276	0.270	0.266	0.256	0.251	0.246	0.243	0.240
(9) MBMW production costs [i]	50.3 50.3	57.0 57.0	61.8 62.3	65.4 66.2	71.4 72.5	77.1 78.4	83.0 84.4	88.8 90.4	97.5 99.3
(10) MBMW profits [j]	8.7	9.7	10.9	12.0	13.9	12.9	14.8	13.1	14.7
(11) MBMW gross value of output [k]	**59.1** **59.1**	**66.7** **66.7**	**72.8** **73.3**	**77.4** **78.3**	**85.3** **86.4**	**89.9** **91.2**	**97.8** **99.2**	**101.9** **103.5**	**112.2** **114.0**

[a] Stephen Rapawy, *Civilian Employment in the USSR: 1950 to 1983* (Washington, DC: US Department of Commerce, Foreign Bureau of the Census, August 1985), p. 3. Employment for 1984 was calculated using Rapawy's estimating technique and data from *Narodnoye khozyaystvo SSSR (Narkhoz) 1984*, pp. 135, 143.

[b] MBMW average wages have been published for 1975-83 in *Vestnik statistiki*, no. 10 (Moscow: 1984), p. 75. During those years, the MBMW average wage was approximately 1.01 times greater than the industry average wage. Assuming this relationship holds for other years, we calculate MBMW annual average wages for 1966-74 as 1.01 times industry average wages, published in *Narkhoz 1967*, p. 657; *Narkhoz 1969*, p. 539; *Narkhoz 1970*, p. 519; and *Narkhoz 1975*, p. 546.

[c] Row 1 times row 2. (Throughout the tables, hand calculations at each step may differ from the printed figures because of rounding in the computer model.)

[d] Social insurance deductions were about 7.2 percent of the wage bill in 1968-81. (See *Spravochnik partiynogo rabotniki* [Moscow: Izdatelstvo Politicheski Literatyra, 1968], pp. 439-40.) We also use this rate for 1966-67. The rate increased to 14 percent in 1982, according to V. V. Zhilyakov and V. P. Bezrukov, *Kontrol za raskhodovaniyem sredst na soderzhaniye apparata upravleniya*, p. 43.

[e] Row 3 plus row 4.

[f] For information on MIF payments, see U. M. Artemov, V. G. Parasochka, and F. P. Safonov, *Finansoviye metodi materialnogo stimylirovaniya proizvodstva* (Moscow: Finansi i statistiki, 1983), pp. 26, 30. Material incentive fund payments for all industry are published annually in the *Narkhoz*, but MIF payments for MBMW have not been released. We do know that MBMW has a larger portion of engineering and technical managers than industry does (see *Trud v SSSR 1968*, pp. 87-88) and that these workers receive most of the MIF payments. Thus, the ratio of MBMW MIF payments to the MBMW wage bill most likely would be higher than the ratio of industry MIF payments to the industry wage bill. We calculate low estimates of annual MBMW MIF payments by multiplying the MBMW wage bill by 1.50 times the industry MIF rate. High estimates are derived by multiplying the industry MIF rate by 1.75. For additional information, see U. Artemov, *Voprosi ekonomiki*, no. 8 (Moscow: 1975), pp. 37-45.

[g] Row 5 minus row 6. At this step—as in all the calculations—the widest range of uncertainty is calculated. For example, the low value for this row equals the value in row 5 minus the high value in row 6.

Table 3 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	13.82	14.30	14.60	14.96	15.24	15.46	15.58	15.69	15.82	16.03
(2)	1.97	2.06	2.09	2.14	2.19	2.25	2.30	2.38	2.42	2.50
(3)	27.21	29.41	30.57	32.06	33.34	34.78	35.84	37.35	38.23	40.05
(4)	1.96	2.12	2.20	2.31	2.40	2.50	2.58	5.23	5.35	5.61
(5)	29.17	31.53	32.77	34.37	35.74	37.29	38.42	42.58	43.59	45.66
(6)	3.59	3.78	3.93	4.08	4.19	4.42	4.61	4.69	4.80	4.97
	4.05	4.27	4.44	4.60	4.73	4.99	5.21	5.30	5.42	5.61
(7)	25.13	27.26	28.33	29.77	31.01	32.30	33.21	37.29	38.17	40.05
	25.59	27.75	28.84	30.30	31.55	32.87	33.81	37.89	38.79	40.69
(8)	0.236	0.240	0.237	0.231	0.228	0.225	0.222	0.229	0.224	0.221
(9)	106.5	113.6	119.5	128.9	136.0	143.5	149.6	162.8	170.4	181.2
	108.4	115.6	121.7	131.1	138.4	146.1	152.3	165.5	173.2	184.1
(10)	16.7	16.3	17.9	20.1	22.5	24.5	25.8	20.1	22.7	25.5
(11)	123.1	129.9	137.4	149.0	158.5	168.1	175.4	182.9	193.0	206.7
	125.1	131.9	139.6	151.3	160.9	170.6	178.1	185.6	195.8	209.6

[h] *Narkhoz 1967*, p. 225; *Narkhoz 1968*, p. 223; *Narkhoz 1969*, p. 187; *Narkhoz 1970*, p. 174; *Narkhoz 1922-1972*, p. 157; *Narkhoz 1972*, p. 196; *Narkhoz 1973*, p. 249; *Narkhoz 1974*, p. 210; *Narkhoz 1975*, p. 230; *Narkhoz za 60 let*, p. 196; *Narkhoz 1977*, p. 141; *Narkhoz 1978*, p. 137; *Narkhoz 1979*, p. 163; *Narkhoz 1980*, p. 153; *Narkhoz 1922-82*, p. 178; *Narkhoz 1982*, p. 139; *Narkhoz 1983*, p. 148; *Narkhoz 1984*, p. 162.

[i] Row 7 divided by row 8.

[j] *Narkhoz 1968*, p. 745; *Narkhoz 1969*, p. 743; *Narkhoz 1975*, p. 727; *Narkhoz 1980*, p. 505; *Narkhoz 1983*, p. 538; and *Narkhoz 1984*, p. 564.

[k] Row 9 plus row 10.

Table 4
Soviet Machine Building and Metalworking:
Gross Value of Output From Amortization Data

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Ratio of MBMW to industry capital stock [a]	0.19	0.20	0.20	0.20	0.20	0.20	0.21	0.21	0.21
(2) Ratio of MBMW to industry amortization rate [b]	1.04	1.03	1.03	1.04	1.04	1.04	1.05	1.05	1.07
(3) Ratio of MBMW to industry amortization charges [c]	0.20	0.20	0.20	0.21	0.21	0.21	0.22	0.22	0.22
(4) Industry amortization charges [d]	11.11	12.06	12.98	14.12	15.54	17.09	18.73	20.57	22.52
(5) MBMW amortization charges [e]	2.22	2.42	2.63	2.90	3.22	3.59	4.09	4.54	5.06
(6) Ratio of amortization to MBMW production costs [f]	0.047	0.046	0.044	0.045	0.046	0.047	0.049	0.051	0.052
(7) MBMW production costs [g]	47.2	52.6	59.7	64.4	70.0	76.4	83.4	89.1	97.3
(8) MBMW profits [h]	8.7	9.7	10.9	12.0	13.9	12.9	14.8	13.1	14.7
(9) MBMW gross value of output [i]	**55.9**	**62.4**	**70.6**	**76.4**	**83.9**	**89.3**	**98.2**	**102.1**	**112.1**

[a] *Narkhoz 1967*, p. 217; *Narkhoz 1968*, p. 215; *Narkhoz 1969*, p. 175; *Narkhoz 1970*, p. 167; *Narkhoz 1922-72*, p. 153; *Narkhoz 1972*, p. 189; *Narkhoz 1973*, p. 237; *Narkhoz 1974*, p. 199; *Narkhoz 1980*, p. 145; and *Narkhoz 1984*, p. 154.

[b] *Narkhoz 1967*, pp. 220-21; *Narkhoz 1968*, p. 218-19; *Narkhoz 1969*, p. 178-79; *Narkhoz 1972*, p. 191; *Narkhoz 1973*, p. 243; *Narkhoz 1974*, p. 207; *Narkhoz 1975*, p. 227; *Narkhoz 1977*, p. 138. For 1966-77 the ratio can be calculated directly. After 1977 the amortization rates are not published. For those years, we apply the 1977 ratio—amortization rates were changed in 1975, and we believe the ratio was stable by 1977.

[c] Row 1 times row 2.

[d] *Narkhoz 1968*, p. 771; *Narkhoz 1970*, p. 729; *Narkhoz 1975*, p. 741; *Narkhoz 1980*, p. 521; and *Narkhoz 1984*, p. 572.

[e] Row 3 times row 4.

[f] *Narkhoz 1967*, p. 225; *Narkhoz 1968*, p. 223; *Narkhoz 1969*, p. 187; *Narkhoz 1970*, p. 174; *Narkhoz 1922-72*, p. 157; *Narkhoz 1972*, p. 196; *Narkhoz 1973*, p. 249; *Narkhoz 1974*, p. 210; *Narkhoz 1975*, p. 230; *Narkhoz* za 60 let, p. 196; *Narkhoz 1977*, p. 141; *Narkhoz 1978*, p. 137; *Narkhoz 1979*, p. 163; *Narkhoz 1980*, p. 153; *Narkhoz 1922-82*, p. 178; *Narkhoz 1982*, p. 139; *Narkhoz 1983*, p. 148; and *Narkhoz 1984*, p. 162.

[g] Row 5 divided by row 6.

[h] *Narkhoz 1968*, p. 745; *Narkhoz 1970*, p. 743; *Narkhoz 1975*, p. 727; *Narkhoz 1980*, p. 505; *Narkhoz 1983*, p. 538; and *Narkhoz 1984*, p. 564.

[i] Row 7 plus row 8.

Table 4 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	0.21	0.22	0.22	0.23	0.23	0.24	0.24	0.24	0.24	0.24
(2)	1.01	1.01	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
(3)	0.22	0.22	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25
(4)	27.33	29.61	32.05	34.48	37.03	39.73	42.88	46.16	49.67	53.30
(5)	5.90	6.52	7.32	8.05	8.80	9.58	10.47	11.37	12.33	13.34
(6)	0.055	0.057	0.060	0.062	0.064	0.066	0.070	0.070	0.073	0.075
(7)	107.2	114.4	121.9	129.8	137.4	145.1	149.6	162.4	168.9	177.9
(8)	16.7	16.3	17.9	20.1	22.5	24.5	25.8	20.1	22.7	25.5
(9)	**123.9**	**130.7**	**139.8**	**149.9**	**159.9**	**169.7**	**175.3**	**182.5**	**191.6**	**203.4**

Table 5
Soviet Machine Building and Metalworking:
Gross Value of Output

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) MBMW gross value of output (GVO), labor force method [a]	59.1 59.1	66.7 66.7	72.8 73.3	77.4 78.3	85.3 86.4	89.9 91.2	97.8 99.2	101.9 103.5	112.2 114.0
(2) MBMW GVO, amortization method [b]	55.9	62.4	70.6	76.4	83.9	89.3	98.2	102.1	112.1
(3) MBMW GVO [c]	**55.9** **59.1**	**62.4** **66.7**	**70.6** **73.3**	**76.4** **78.3**	**83.9** **86.4**	**89.3** **91.2**	**97.8** **99.2**	**101.9** **103.5**	**112.1** **114.0**

[a] Table 3, row 11.
[b] Table 4, row 9.
[c] The values for MBMW GVO are a range between the low and high values in rows 1 and 2.

Table 5 (continued)

Billion current rubles

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	123.1	129.9	137.4	149.0	158.5	168.1	175.4	182.9	193.0	206.7
	125.1	131.9	139.6	151.3	160.9	170.6	178.1	185.6	195.8	209.6
(2)	123.9	130.7	139.8	149.9	159.9	169.7	175.3	182.5	191.6	203.4
(3)	**123.1**	**129.9**	**137.4**	**149.0**	**158.5**	**168.1**	**175.3**	**182.5**	**191.6**	**203.4**
	125.1	**131.9**	**139.8**	**151.3**	**160.9**	**170.6**	**178.1**	**185.6**	**195.8**	**209.6**

Table 6
Soviet Machine Building and Metalworking: Deliveries to Final Demand

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) MBMW gross value of output [a]	55.9	62.4	70.6	76.4	83.9	89.3	97.8	101.9	112.1
	59.1	66.7	73.3	78.3	86.4	91.2	99.2	103.5	114.0
(2) Final demand ratio [b]	0.57	0.56	0.56	0.55	0.54	0.54	0.53	0.52	0.52
	0.59	0.58	0.58	0.57	0.56	0.56	0.55	0.55	0.55
(3) MBMW deliveries to final demand [c]	31.9	34.9	39.6	42.0	45.3	48.2	51.8	53.0	58.3
	34.8	38.7	42.5	44.6	48.4	51.1	54.6	56.9	62.7

[a] Table 5, row 3.

[b] Vladimir G. Treml, Barry L. Kostinsky, and Dimitri M. Gallik, "1966 Ex Post Input-Output Tables for the USSR: A Survey," in V. Treml, ed., *Studies in Soviet Input-Output Analysis* (New York: Praeger, 1977), pp. 47, 49; Dimitri M. Gallik, Barry L. Kostinsky, and Vladimir G. Treml, *Input-Output Structure of the Soviet Economy: 1972* (Washington, D. C.: US Department of Commerce, Bureau of Economic Analysis, April 1983), p. 76; and Dimitri M. Gallik, Meredith Heinemeier, Barry L. Kostinsky, Vladimir G. Treml, and Albina Tretyakova, *Construction of a 1977 Soviet Input-Output Table* (Washington, D. C.: US Department of Commerce, Bureau of the Census, January 1984), p. 8. For 1966-72 we interpolate between the 1966 and 1972 ratios of 0.58 and 0.54, respectively. The 1977 ratio of 0.52 is taken from a Western construction of a Soviet input-output table. We range the ratio from 0.50 to 0.54 to convey the uncertainty. Low ratios for 1972-77 are calculated by interpolating, using 0.50 for 1977, and high ratios are calculated using 0.54 for 1977. After 1977, we calculate low ratios by continuing the trend established from 1972-77 and assign the 1977 ratio of 0.54 as the high ratio for each year.

[c] Row 1 times row 2.

Table 6 (continued

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	123.1	129.9	137.4	149.0	158.5	168.1	175.3	182.5	191.6	203.4
	125.1	131.9	139.8	151.3	160.9	170.6	178.1	185.6	195.8	209.6
(2)	0.51	0.51	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.46
	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
(3)	**62.8**	**66.2**	**68.7**	**73.0**	**77.7**	**80.7**	**84.2**	**85.8**	**90.0**	**93.6**
	67.5	**71.2**	**75.5**	**81.7**	**86.9**	**92.1**	**96.2**	**100.2**	**105.7**	**113.2**

Table 7
Soviet Net Machinery Imports

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Reported machinery exports [a]	1.8	1.9	2.3	2.4	2.6	2.8	3.2	3.7	4.3
	1.8	2.1	2.4	2.5	2.7	3.0	3.4	4.0	4.5
(2) Export residual [b]	1.1	1.3	1.6	1.9	2.1	2.1	2.7	3.3	3.5
	1.2	1.5	1.6	2.1	2.0	2.2	3.2	3.4	3.7
(3) Total machinery exports, foreign trade prices [c]	2.3	2.6	3.0	3.4	3.6	3.9	4.5	5.3	6.0
	2.9	3.4	3.8	4.4	4.5	5.0	6.3	7.1	7.8
(4) Foreign-to-domestic conversion coefficient [d]	0.69	0.72	0.75	0.78	0.82	0.85	0.89	0.90	0.91
	0.73	0.76	0.79	0.82	0.86	0.89	0.93	0.94	0.95
(5) Total machinery exports, purchasers' prices [e]	1.6	1.9	2.3	2.6	3.0	3.3	4.0	4.8	5.5
	2.1	2.6	3.0	3.6	3.9	4.4	5.8	6.6	7.4
(6) Purchasers'-to-producers' conversion coefficient [f]	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.88
	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.92
(7) Total machinery exports, producers' prices [g]	1.4	1.7	2.0	2.3	2.6	3.0	3.6	4.3	4.8
	2.0	2.5	2.9	3.3	3.6	4.1	5.4	6.2	6.8
(8) Reported machinery imports [h]	1.9	2.1	2.5	2.9	3.1	3.1	3.8	4.3	5.0
	2.0	2.3	2.7	3.1	3.3	3.3	4.0	4.7	5.4
(9) Import residual [i]	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	1.0
	0.4	0.4	0.5	0.5	0.6	0.6	0.8	0.9	1.1
(10) Total machinery imports, foreign trade prices [j]	2.0	2.3	2.7	3.1	3.3	3.3	4.1	4.7	5.4
	2.3	2.6	3.1	3.4	3.8	3.8	4.6	5.3	6.1
(11) Foreign-to-domestic conversion coefficient [k]	0.69	0.73	0.77	0.81	0.86	0.91	0.96	0.96	0.96
	0.73	0.77	0.81	0.85	0.90	0.95	1.00	1.00	1.00
(12) Total machinery imports, purchasers' prices [l]	1.4	1.7	2.1	2.5	2.9	3.0	3.9	4.5	5.2
	1.7	2.0	2.5	2.9	3.4	3.6	4.6	5.3	6.1
(13) Purchasers'-to-producers' conversion coefficient [m]	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.88
	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.92
(14) Total machinery imports, producers' prices [n]	1.3	1.5	1.9	2.2	2.6	2.7	3.5	4.0	4.6
	1.6	1.9	2.4	2.7	3.2	3.3	4.3	4.9	5.6
(15) Net machinery imports, producers' prices [o]	**−0.7**	**−1.0**	**−1.0**	**−1.1**	**−1.0**	**−1.4**	**−2.0**	**−2.2**	**−2.3**
	0.2	**0.2**	**0.3**	**0.4**	**0.5**	**0.4**	**0.7**	**0.6**	**0.8**

[a] *Narkhoz 1968*, pp. 657-58; *Narkhoz 1969*, pp. 652-53; *Narkhoz 1972*, pp. 738-741; *Narkhoz 1975*, pp. 754, 756; *Narkhoz 1980*, pp. 537, 540; *Narkhoz 1983*, pp. 560, 563; and *Narkhoz 1984*, pp. 586, 589. There may be a timelag between the production and reporting of machinery as exports. We assume the lag ranges from six months to one year, on the basis of research in Philip Hanson, *Trade and Technology in Soviet-Western Relations* (New York: Columbia University Press, 1981), pp. 124-25. The low numbers in row 1 include a six-month lag and the high values a one-year lag.

[b] Hanson, *Trade*. For additional information on the unidentified trade residuals, see Barry L. Kostinsky, *Description and Analysis of Soviet Foreign Trade Statistics* (Washington, D. C.: US Department of Commerce, Bureau of Economic Analysis, July 1974), pp. 46-56, 69.

[c] The low estimate includes the reported machinery export data in row 1 and 50 percent of the export residual in row 2, and the high estimate includes the reported data and 90 percent of the residual.

[d] A 1966 foreign-to-domestic conversion coefficient of 0.71 was calculated in Barry L. Kostinsky and Vladimir G. Treml, *Foreign Trade Pricing in the Soviet Input-Output Table*, (Washington, D. C.: US Department of Commerce, Bureau of Economic Analysis, March 1976), pp. 10-11. A coefficient of 0.91 for 1972 was derived in Vladimir Treml and Barry Kostinsky, *Domestic Value of Soviet Foreign Trade Statistics*, (Washington, D. C.: US Department of Commerce, Bureau of the Census, October 1982), pp. 46, 53. The Bureau of the Census has estimated a preliminary coefficient of 1.00 for 1982. Because of the uncertainty, each coefficient was ranged plus or minus 0.02. We calculate a complete time series by interpolating and extrapolating.

[e] Row 3 times row 4.

[f] Treml, Kostinsky, and Gallik, "1966," pp. 29, 49; Gallik, Kostinsky, and Treml, *Input-Output Structure*, pp. 48, 76; and Gallik, et al., *Construction*, pp. 34, 37. Purchasers'-to-producers' price conversion coefficients of 0.92 in 1966, 0.91 in 1972, and 0.89 in 1977 can be calculated from these three input-output tables. Given the error introduced by employing commodity-based data, each coefficient is ranged plus or minus 0.02. Estimates for remaining years are interpolated and extrapolated.

[g] Row 5 times row 6.

[h] See note a for sources. V. Faltsman reported in "Strukturniye izmeneniya v mezhotraslevikh potokakh orudiyu truda," *Voprosi ekonomiki*, no. 7 (Moscow: 1976), p. 57, that 15 percent of all machinery imports was directed to production enterprises. Since we want only imports directed to final demand, we subtract 12 to 18 percent of machinery imports—allowing for uncertainty and changes over time.

Table 7 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	4.9	5.8	6.6	7.2	7.6	7.8	7.9	8.3	8.9	9.7
	5.4	6.3	7.0	7.4	7.8	7.8	8.1	8.5	9.3	10.2
(2)	4.1	5.3	6.4	7.1	7.3	8.1	9.5	10.4	11.0	11.5
	4.5	6.0	6.8	7.3	7.3	8.9	10.2	10.7	11.2	11.8
(3)	7.0	8.5	9.8	10.7	11.2	11.8	12.7	13.5	14.4	15.5
	9.4	11.7	13.1	14.0	14.4	15.8	17.3	18.1	19.4	20.8
(4)	0.92	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
	0.96	0.97	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04
(5)	6.4	7.8	9.2	10.1	10.7	11.4	12.3	13.3	14.2	15.5
	9.1	11.3	12.7	13.7	14.2	15.8	17.5	18.5	20.0	21.6
(6)	0.88	0.87	0.87	0.87	0.86	0.86	0.85	0.85	0.85	0.84
	0.92	0.91	0.91	0.91	0.90	0.90	0.89	0.89	0.89	0.88
(7)	5.7	6.8	8.0	8.8	9.2	9.8	10.5	11.3	12.1	13.0
	8.3	10.3	11.6	12.5	12.8	14.2	15.5	16.5	17.8	19.0
(8)	7.4	8.5	9.4	11.9	11.8	12.4	13.0	15.9	18.7	19.6
	7.9	9.2	10.1	12.8	12.7	13.3	14.0	17.1	20.1	21.0
(9)	1.1	1.3	1.6	1.7	1.7	2.4	3.0	3.4	3.6	4.0
	1.2	1.4	1.8	1.8	1.8	2.6	3.2	3.6	3.9	4.3
(10)	7.8	9.1	10.1	12.6	12.5	13.3	14.2	17.3	20.1	21.2
	8.8	10.1	11.4	14.1	14.0	15.1	16.2	19.6	22.8	24.1
(11)	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98
	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02
(12)	7.6	8.8	9.8	12.2	12.1	13.1	13.9	16.9	19.7	20.8
	8.9	10.2	11.5	14.2	14.1	15.4	16.5	20.0	23.2	24.5
(13)	0.88	0.87	0.87	0.87	0.86	0.86	0.85	0.85	0.85	0.84
	0.92	0.91	0.91	0.91	0.90	0.90	0.89	0.89	0.89	0.88
(14)	6.7	7.6	8.5	10.6	10.4	11.2	11.8	14.4	16.8	17.5
	8.2	9.3	10.4	12.9	12.7	13.8	14.7	17.8	20.7	21.6
(15)	−1.7	−2.7	−3.1	−1.8	−2.4	−3.0	−3.7	−2.1	−1.0	−1.6
	2.5	2.5	2.5	4.1	3.5	4.1	4.2	6.5	8.6	8.6

[i] See note b for sources. As in row 8, we estimate that 12 to 18 percent of the residual trade is directed to production enterprises.

[j] The low estimate includes the reported machinery imports and 40 percent of the overall trade residual, while the high estimate includes the reported machinery imports and 70 percent of the overall trade residual. (According to Jan Vanous, *Centrally Planned Economies: Current Analysis*, 15 August 1984, imports of military arms from socialist countries totaled about 2 billion rubles in 1983. We believe the value of this trade—which is about 50 percent of the import residual—made up a major portion of total arms imports.)

[k] Foreign-to-domestic conversion coefficients of 0.71 and 0.978 were calculated for 1966 and 1972 in Kostinsky and Treml, *Foreign Trade Pricing*, pp. 10-11, and Gallik, Kostinsky, and Treml, *Input-Output Structure*, p. 54. A preliminary coefficient of 1.00 has been estimated for 1982 by the Bureau of the Census. We range each of these coefficients plus or minus 0.02 to account for the uncertainty. Ratios for the remaining years are estimated by interpolating and extrapolating.

[l] Row 10 times row 11.

[m] These price conversion coefficients are the same as those in row 6.

[n] Row 12 times row 13.

[o] Row 14 minus row 7.

Table 8
Soviet Civilian Machinery Purchases: Producer Durables

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Machinery and equipment	17.9	19.4	21.4	23.9	25.9	27.7	29.9	32.6	35.6
component of investment [a]	18.6	20.3	22.5	25.3	26.6	28.8	31.1	34.1	37.1
(2) Non-MBMW products [b]	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.8
	1.9	2.0	2.3	2.5	2.7	2.9	3.1	3.4	3.7
(3) MBMW component of	16.0	17.4	19.1	21.4	23.3	24.8	26.8	29.2	31.9
investment, estimate prices [c]	17.7	19.3	21.4	24.1	25.3	27.4	29.6	32.5	35.3
(4) Purchases by budget-	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4
supported institutions [d]	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8
(5) Change in stocks of uninstalled	0.2	0.5	0.5	−0.1	−0.1	0.1	0.1	−0.1	0.6
equipment [e]	0.5	0.8	0.8	1.0	1.0	0.6	0.7	0.8	0.9
(6) Producer durables, purchasers'	17.3	19.0	20.7	22.5	24.4	26.2	28.2	30.5	33.8
and estimate prices [f]	19.6	21.6	23.7	26.7	27.9	29.7	32.0	35.1	38.0
(7) Producer durables, producers'	16.5	18.1	19.7	21.4	23.2	24.9	26.8	29.0	32.1
prices [g]	18.6	20.5	22.5	25.4	26.5	28.2	30.4	33.3	36.1
(8) Civilian purchases of producer	**13.2**	**14.5**	**15.8**	**17.1**	**18.6**	**19.9**	**21.5**	**23.2**	**25.7**
durables, producers' prices [h]	**16.8**	**18.4**	**20.2**	**22.8**	**23.9**	**25.4**	**27.4**	**30.0**	**32.5**

[a] *Narkhoz 1975*, p. 503; *Narkhoz 1980*, p. 334; and *Narkhoz 1984*, p. 376. The low values represent a six-month timelag between production of machinery and its incorporation into investment, while the high values represent a one-year lag. We believe that investment prices did not change between price reforms, which occurred in 1969, 1973, and 1984. Thus, our current price series represents 1955 comparable prices through 1968, 1969 comparable prices for 1969 to 1972, 1973 comparable prices until 1983, and 1984 comparable prices for 1984. (See footnotes in *Narkhoz 1968*, p. 511; *Narkhoz 1975*, p. 495; *Narkhoz 1980*, p. 327; and *Narkhoz 1984*, p. 468.)

[b] Michael Boretsky, "The Technical Base of Soviet Military Power," *Economic Performance and the Military Burden in the Soviet Union* (Washington, D. C.: Joint Economic Committee, 1970), p. 229. Boretsky estimates that 5 to 10 percent of the machinery and equipment component of investment in equipment, tools, and implements are actually non-MBMW products. We deduct 10 percent from our low estimate and 5 percent from our high estimate.

[c] Row 1 minus row 2.

[d] The acquisition of equipment by budget-supported institutions has not been included in Soviet investment data since 1964. Values for 1960-64 can be calculated by comparing the investment data in *Narkhoz 1964*, p. 511 (which includes the equipment purchases) with the data in *Narkhoz 1965*, p. 528 (which excludes the equipment purchases). These outlays made up 1 percent of total union-republic budgets from 1976-80. We calculate a complete time series by interpolating and extrapolating through the 1960-64 and 1976-80 data points. We believe these data are in current prices.

[e] No complete time series on changes to uninstalled stock at construction sites is available in Soviet literature. From scattered reports we established a series for 1966-84, which we consider to be in current prices. See John Pitzer, *Gross National Product of the USSR, 1950-80*, (Washington, D. C.: Joint Economic Committee, 8 December 1982), p. 139; A. Vozyakov, "Povyshat effektivnost kapitalnogo stroitelstva," *Finansy SSSR*, no. 8 (Moscow: 1967), p. 7; and Scot Butler, "The Soviet Capital Investment Program," *Economic Performance and the Military Burden in the Soviet Union* (Washington, D. C.: Joint Economic Commitee, 1970), p. 46.

[f] Row 3 plus row 4 plus row 5.

[g] Row 6 times 0.95. Boretsky, "Technical," p. 229. He estimates that producers' prices are 95 percent of both estimate prices and producers' prices.

[h] The low estimate equals the low value of row 7 times 0.80. The high estimate equals the high value of row 7 times 0.90. We assume that 10 to 20 percent of total producer durables represents military purchases of machinery known as common-use durables.

Table 8 (continued)

Billion current rubles

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	38.9	41.8	44.8	47.4	49.3	51.8	54.6	57.8	62.0	64.8
	40.7	43.0	46.6	48.3	50.2	53.4	55.9	59.7	64.3	65.4
(2)	1.9	2.1	2.2	2.4	2.5	2.6	2.7	2.9	3.1	3.2
	4.1	4.3	4.7	4.8	5.0	5.3	5.6	6.0	6.4	6.5
(3)	34.8	37.5	40.1	42.6	44.2	46.5	49.1	51.8	55.6	58.3
	38.8	40.9	44.4	45.9	47.7	50.8	53.2	56.8	61.2	62.2
(4)	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8
	1.7	1.8	1.8	1.9	1.9	2.1	2.1	2.2	2.2	2.3
(5)	0.1	0.1	0.1	0.1	0.1	−0.1	0.1	0.1	0.1	0.1
	0.4	0.5	0.6	0.6	0.6	0.3	0.3	0.6	0.6	0.6
(6)	36.1	38.8	41.5	44.1	45.7	47.9	50.8	53.6	57.4	60.2
	40.9	43.2	46.8	48.4	50.2	53.2	55.6	59.6	64.0	65.1
(7)	34.3	36.9	39.5	41.9	43.4	45.5	48.2	50.9	54.5	57.2
	38.8	41.0	44.4	46.0	47.7	50.5	52.8	56.6	60.8	61.8
(8)	**27.5**	**29.5**	**31.6**	**33.5**	**34.8**	**36.4**	**38.6**	**40.8**	**43.6**	**45.8**
	34.9	**36.9**	**40.0**	**41.4**	**43.0**	**45.5**	**47.5**	**51.0**	**54.7**	**55.6**

Table 9
Soviet Civilian Machinery Purchases: Consumer Durables

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Consumer durables, commodity basis [a]	4.8	NA	NA	NA	NA	NA	8.3	NA	NA
(2) Consumer durables, establishment basis [b]	4.4 4.6	4.8 5.0	5.2 5.5	5.7 6.0	6.3 6.6	6.9 7.2	7.5 7.9	8.1 8.6	8.8 9.3
(3) Material inputs to science [c]	2.9	3.1	3.5	3.8	4.5	4.9	5.4	5.8	6.1
(4) Ratio of machinery material inputs to total material inputs [d]	0.40 0.41	0.38 0.42	0.39 0.43	0.40 0.44	0.41 0.45	0.42 0.46	0.43 0.47	0.44 0.48	0.45 0.49
(5) Machinery component of material inputs to science [e]	1.1 1.2	1.2 1.3	1.4 1.5	1.5 1.7	1.8 2.0	2.1 2.3	2.3 2.5	2.6 2.8	2.7 3.0
(6) Military machinery component of material inputs to science [f]	0.5 0.9	0.6 1.0	0.7 1.1	0.8 1.3	0.9 1.5	1.0 1.7	1.2 1.9	1.3 2.1	1.4 2.2
(7) Civilian purchases of consumer durables [g]	3.5 4.1	3.8 4.4	4.1 4.8	4.4 5.2	4.8 5.7	5.2 6.2	5.6 6.7	6.1 7.3	6.5 7.9

[a] The Soviets reported commodity-based public and private consumption for 1966 and 1972 in the input-output tables.

[b] We convert row 1 to establishment basis using the coefficient 1.05 to 1.10 for MBMW GVO and estimate values for 1967 through 1971 by interpolating. On the basis of research by Ray Converse, "An Index of Industrial Production in the USSR," *USSR: Measures of Economic Growth and Development: 1950-1980* (Washington, D. C.: Joint Economic Committee, December 1982), pp. 169-244, and subsequent updates of the series, we believe that annual growth in consumption dropped after 1972 to about one-half of the pre-1972 rate in constant prices. To estimate consumer durables in current prices after 1972, we extrapolate by gradually lowering the growth rate—allowing for uncertainty—to one-half that suggested by the 1966 and 1972 data.

[c] We digress at this step to estimate military purchases of consumer durables. Material inputs to science, a component of consumer durables, may include military machinery. The data are taken from an updated series based on Pitzer, *Gross National Product*, p. 110.

[d] V. M. Rutgayzer, *Resursy razvitiya neproizvodstvennoy sfery* (Moscow: Mysl', 1975), p. 168. Rutgayzer stated that, in 1970, machinery purchases were 43 percent of total material inputs to science (exclusive of depreciation). The machinery share has most likely increased since 1970. Since we do not know the rate of increase, we range the 1970 figure as 41 to 45 percent and then increase it by 1 percentage point each year through 1984 (and decrease by 1 percentage point annually from 1970 back to 1966).

[e] Row 3 times row 4.

[f] Our best estimate is that 50 to 75 percent of the machinery portion of material inputs to science in any given year represents purchases by the military.

[g] Row 2 minus row 6. At this final step, the military purchases of machinery material inputs are subtracted from total consumer durables to calculate civilian purchases of consumer durables.

Table 9 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(2)	9.3	9.9	10.3	10.8	11.3	11.8	12.3	12.9	13.4	14.1
	9.9	10.5	11.0	11.5	12.1	12.7	13.4	14.0	14.7	15.4
(3)	6.5	6.6	6.8	7.2	7.5	8.3	8.7	9.3	9.7	10.1
(4)	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.50
	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.50
(5)	3.0	3.1	3.3	3.5	3.8	4.2	4.5	4.9	5.2	5.6
	3.3	3.4	3.5	3.8	4.0	4.6	4.9	5.3	5.6	6.0
(6)	1.5	1.6	1.6	1.8	1.9	2.1	2.3	2.5	2.6	2.8
	2.4	2.5	2.7	2.9	3.0	3.4	3.7	4.0	4.2	4.5
(7)	6.9	7.3	7.6	7.9	8.2	8.3	8.6	8.9	9.2	9.6
	8.4	8.9	9.3	9.8	10.2	10.6	11.1	11.5	12.1	12.7

Table 10
Soviet Civilian Machinery Purchases: Capital Repair

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Amortization deductions [a]	8.9 10.4	9.6 11.3	10.4 12.3	11.4 13.4	12.5 14.7	13.7 16.1	15.1 17.8	16.7 19.6	18.3 21.5
(2) Budget expenditures [b]	1.9 2.1	2.0 2.2	2.1 2.3	2.2 2.5	2.4 2.6	2.7 3.0	2.8 3.1	3.1 3.4	3.4 3.8
(3) *Kolkhoz* expenditures [c]	0.6 0.8	0.6 0.8	0.7 0.9	0.8 1.0	0.8 1.0	0.9 1.1	1.1 1.3	1.2 1.4	1.2 1.4
(4) Total capital repair [d]	11.3 13.3	12.2 14.4	13.2 15.5	14.4 16.9	15.6 18.3	17.3 20.3	19.0 22.3	20.9 24.5	22.9 26.8
(5) Ratio of capital repair of machinery to total capital repair [e]	0.53 0.57	0.54 0.58	0.55 0.59	0.56 0.60	0.57 0.61	0.57 0.61	0.57 0.61	0.57 0.61	0.57 0.61
(6) Capital repair of machinery [f]	6.0 7.6	6.6 8.3	7.2 9.2	8.1 10.1	8.9 11.2	9.8 12.4	10.8 13.6	11.9 14.9	13.0 16.3
(7) Civilian share of capital repair of machinery [g]	0.57 0.89	0.56 0.90	0.55 0.86	0.58 0.92	0.58 0.90	0.60 0.92	0.60 0.94	0.64 1.00	0.63 1.00
(8) Capital repair of civilian machinery [h]	3.4 6.7	3.7 7.5	4.0 7.8	4.7 9.3	5.1 10.0	5.9 11.4	6.5 12.8	7.6 14.9	8.2 16.3

[a] *Narkhoz 1968*, p. 771; *Narkhoz 1970*, p. 729; *Narkhoz 1975*, p. 741; *Narkhoz 1980*, p. 521; *Narkhoz 1983*, p. 547; and *Narkhoz 1984*, p. 572. Amortization deductions do not always represent actual expenditures on capital repair. Rather, these deductions are funds set aside as a result of the amortization charges on plants and equipment. From 1951-62, amortization deductions were, in general, larger than capital repair expenditures for any given year. See M. Eydel'man, *Mezhotraslevoy balans obshchestvennogo produkta* (Moscow: 1966), p. 207. We calculate low estimates of capital repair expenditures for 1966-84 as 85 percent of reported amortization deductions and high estimates as 100 percent of the reported figures.

[b] *Gosudarstvennyy byudzhet SSSR (Gos byudzhet), 1966-70*, (Moscow: Gosfinizdat, 1966), p. 81; *Gos byudzhet 1971-75*, p. 78; *Gos byudzhet 1976-80*, p. 51. Later values are extrapolated at the rate for 1976-80, plus or minus 5 percent. See Scot Butler, *The Growth of Capital Repair in the USSR, 1950-1977*, (CIA, working paper, March 1979), p. 63.

[c] Butler, *Growth*, pp. 2-3. We place a range of uncertainty around a series developed by Butler using scattered sources of information.

[d] Row 1 plus row 2 plus row 3.

[e] Butler, *Growth*, p. 53. The share of total capital repair allocated to machinery was 43, 59, and 54 percent, respectively, in 1959, 1970, and 1976. (The share increased in 1970 due to the revaluation of capital stock.) To develop a time series, we range each reported figure plus or minus 2 percent and interpolate and extrapolate for the remaining years. We assume the share has remained at 54 percent since 1976.

[f] Row 4 times row 5.

[g] We have been unable to find information separating repair of military and civilian machinery. To estimate the share of capital repair used by the military, we employ the estimating technique developed by DIA. This approach assumes that the ratio of money spent on capital repair of machinery by the military is similar to the ratio of money spent on machinery by the military. Capital repair expenditures are more closely related to capital stock than to annual machinery purchases. Because of the lack of stock data, however, we must rely on annual purchases. Thus, for a ratio of capital repair going to the military, we use the ratio of the machinery purchases residual to MBMW deliveries to final demand, both exclusive of repair. The low share equals the low estimates of military purchases of producer and consumer durables divided by the low estimate of MBMW deliveries to final demand less the high estimate of capital repair of machinery. The high share equals the high estimates of military purchases of producer and consumer durables divided by the high estimate of MBMW deliveries to final demand less the low estimate of capital repair of machinery.

[h] Row 7 times row 8.

Table 10 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	17.9	19.3	20.7	22.2	23.7	25.1	26.8	28.6	30.7	32.5
	21.1	22.6	24.4	26.1	27.9	29.6	31.6	33.7	36.1	38.2
(2)	3.8	4.1	4.5	4.8	5.0	5.3	5.7	6.2	6.6	7.1
	4.2	4.6	5.0	5.3	5.6	5.9	6.3	6.8	7.3	7.8
(3)	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.4	2.6
	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.6	2.8
(4)	22.9	24.7	26.6	28.5	30.4	32.3	34.5	36.9	39.5	42.0
	26.8	28.9	31.1	33.2	35.5	37.7	40.2	43.0	46.1	49.0
(5)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
(6)	11.9	12.9	13.9	14.8	15.8	16.8	17.9	19.2	20.6	21.8
	15.0	16.2	17.4	18.6	19.9	21.1	22.5	24.1	25.8	27.4
(7)	0.57	0.59	0.60	0.56	0.56	0.54	0.55	0.53	0.52	0.51
	0.94	0.97	1.00	0.97	0.96	0.99	1.00	1.00	1.00	1.00
(8)	**6.8**	**7.6**	**8.3**	**8.2**	**8.8**	**9.1**	**9.9**	**10.2**	**10.7**	**11.2**
	14.1	**15.7**	**17.4**	**18.1**	**19.1**	**20.9**	**22.5**	**24.1**	**25.8**	**27.4**

Table 11
Soviet Machine Building and Metalworking: Military Purchases

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) MBMW gross value of output [a]	55.9 59.1	62.4 66.7	70.6 73.3	76.4 78.3	83.9 86.4	89.3 91.2	97.8 99.2	101.9 103.5	112.1 114.0
(2) Final demand ratio [b]	0.57 0.59	0.56 0.58	0.56 0.58	0.55 0.57	0.54 0.56	0.54 0.56	0.53 0.55	0.52 0.55	0.52 0.55
(3) MBMW deliveries to final demand [c]	31.9 34.8	34.9 38.7	39.6 42.5	42.0 44.6	45.3 48.4	48.2 51.1	51.8 54.6	53.0 56.9	58.3 62.7
(4) Net machinery imports [d]	−0.7 0.2	−1.0 0.2	−1.0 0.3	−1.1 0.4	−1.0 0.5	−1.4 0.4	−2.0 0.7	−2.2 0.6	−2.3 0.8
(5) Civilian purchases of producer durables [e]	13.2 16.8	14.5 18.4	15.8 20.2	17.1 22.8	18.6 23.9	19.9 25.4	21.5 27.4	23.2 30.0	25.7 32.5
(6) Civilian purchases of consumer durables [f]	3.5 4.1	3.8 4.4	4.1 4.8	4.4 5.2	4.8 5.7	5.2 6.2	5.6 6.7	6.1 7.3	6.5 7.9
(7) Capital repair of civilian machinery [g]	3.4 6.7	3.7 7.5	4.0 7.8	4.7 9.3	5.1 10.0	5.9 11.4	6.5 12.8	7.6 14.9	8.2 16.3
(8) Military purchases of machinery [h]	3.6 14.9	3.6 16.9	5.7 19.0	3.5 18.8	4.7 20.4	3.9 20.4	3.0 21.7	−1.4 20.7	−0.7 23.0
(9) MBMW wholesale price index [i]	1.030	1.030	1.030	1.000	1.000	0.923	0.923	0.872	0.846
(10) Military purchases of machinery *(1970 comparable prices)* [j]	3.5 14.4	3.5 16.4	5.5 18.4	3.5 18.8	4.7 20.4	4.2 22.1	3.2 23.5	−1.6 23.8	−0.9 27.2

[a] Table 5, row 3.
[b] Table 6, row 2.
[c] Row 1 times row 2. See also table 6, row 3.
[d] Table 7, row 15.
[e] Table 8, row 8.
[f] Table 9, row 7.
[g] Table 10, row 8.
[h] The low residual equals the low values in rows 3 and 4 minus the high values in rows 5, 6, and 7. The high residual equals the high values in rows 3 and 4 minus the low values in rows 5, 6, and 7.
[i] We convert our residual estimate to 1970 comparable prices using the published MBMW wholesale price index. *Narkhoz 1970*, p. 175; *Narkhoz 1975*, p. 231; *Narkhoz 1979*, p. 164; and *Vestnik statistiki*, no. 9 (Moscow: 1984), p. 79.
[j] Row 8 divided by row 9.

Table 11 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	123.1	129.9	137.4	149.0	158.5	168.1	175.3	182.5	191.6	203.4
	125.1	131.9	139.8	151.3	160.9	170.6	178.1	185.6	195.8	209.6
(2)	0.51	0.51	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.46
	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
(3)	62.8	66.2	68.7	73.0	77.7	80.7	84.2	85.8	90.0	93.6
	67.5	71.2	75.5	81.7	86.9	92.1	96.2	100.2	105.7	113.2
(4)	−1.7	−2.7	−3.1	−1.8	−2.4	−3.0	−3.7	−2.1	−1.0	−1.6
	2.5	2.5	2.5	4.1	3.5	4.1	4.2	6.5	8.6	8.6
(5)	27.5	29.5	31.6	33.5	34.8	36.4	38.6	40.8	43.6	45.8
	34.9	36.9	40.0	41.4	43.0	45.5	47.5	51.0	54.7	55.6
(6)	6.9	7.3	7.6	7.9	8.2	8.3	8.6	8.9	9.2	9.6
	8.4	8.9	9.3	9.8	10.2	10.6	11.1	11.5	12.1	12.7
(7)	6.8	7.6	8.3	8.2	8.8	9.1	9.9	10.2	10.7	11.2
	14.1	15.7	17.4	18.1	19.1	20.9	22.5	24.1	25.8	27.4
(8)	3.7	2.0	−1.1	1.9	3.0	0.7	−0.6	−2.9	−3.6	−3.7
	28.9	29.3	30.5	36.2	38.6	42.4	43.3	46.9	50.8	55.2
(9)	0.846	0.821	0.795	0.795	0.769	0.769	0.769	0.759	0.759	0.759
(10)	4.4	2.4	−1.4	2.3	3.9	0.9	−0.8	−3.9	−4.7	−4.9
	34.1	35.7	38.3	45.5	50.2	55.1	56.3	61.8	66.9	72.8

Table 12
Soviet Machine Building and Metalworking: Military Purchases as a Pure Residual

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) MBMW gross value of output [a]	55.9	62.4	70.6	76.4	83.9	89.3	97.8	101.9	112.1
	59.1	66.7	73.3	78.3	86.4	91.2	99.2	103.5	114.0
(2) Final demand ratio [b]	0.57	0.56	0.56	0.55	0.54	0.54	0.53	0.52	0.52
	0.59	0.58	0.58	0.57	0.56	0.56	0.55	0.55	0.55
(3) MBMW deliveries to final demand [c]	31.9	34.9	39.6	42.0	45.3	48.2	51.8	53.0	58.3
	34.8	38.7	42.5	44.6	48.4	51.1	54.6	56.9	62.7
(4) Net machinery imports [d]	−0.7	−1.0	−1.0	−1.1	−1.0	−1.4	−2.0	−2.2	−2.3
	0.2	0.2	0.3	0.4	0.5	0.4	0.7	0.6	0.8
(5) Reported purchases of producer durables [e]	16.5	18.1	19.7	21.4	23.2	24.9	26.8	29.0	32.1
	18.6	20.5	22.5	25.4	26.5	28.2	30.4	33.3	36.1
(6) Reported purchases of consumer durables [f]	4.4	4.8	5.2	5.7	6.3	6.9	7.5	8.1	8.8
	4.6	5.0	5.5	6.0	6.6	7.2	7.9	8.6	9.3
(7) Reported capital repair of machinery [g]	6.0	6.6	7.2	8.1	8.9	9.8	10.8	11.9	13.0
	7.6	8.3	9.2	10.1	11.2	12.4	13.6	14.9	16.3
(8) Pure machinery residual [h]	**0.4**	**0.1**	**1.4**	**−0.6**	**−0.0**	**−1.0**	**−2.0**	**−6.0**	**−5.7**
	8.1	**9.4**	**10.6**	**9.8**	**10.5**	**9.8**	**10.1**	**8.5**	**9.6**

[a] Table 5, row 3.
[b] Table 6, row 2.
[c] Row 1 times row 2. See also table 6, row 3.
[d] Table 7, for 15.
[e] Table 8, row 7.
[f] Table 9, row 2.
[g] Table 10, row 6.
[h] For the pure residual estimate, we assume that there were no purchases of military machinery in official figures on new fixed investment, public consumption, and capital repair. The low residual equals the low values in rows 3 and 4 minus the high values in rows 5, 6, and 7. The high residual equals the high values in rows 3 and 4 minus the low values in rows 5, 6, and 7.

Table 12 (continued)

Billion current rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
(1)	123.1	129.9	137.4	149.0	158.5	168.1	175.3	182.5	191.6	203.4
	125.1	131.9	139.8	151.3	160.9	170.6	178.1	185.6	195.8	209.6
(2)	0.51	0.51	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.46
	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
(3)	62.8	66.2	68.7	73.0	77.7	80.7	84.2	85.8	90.0	93.6
	67.5	71.2	75.5	81.7	86.9	92.1	96.2	100.2	105.7	113.2
(4)	−1.7	−2.7	−3.1	−1.8	−2.4	−3.0	−3.7	−2.1	−1.0	−1.6
	2.5	2.5	2.5	4.1	3.5	4.1	4.2	6.5	8.6	8.6
(5)	34.3	36.9	39.5	41.9	43.4	45.5	48.2	50.9	54.5	57.2
	38.8	41.0	44.4	46.0	47.7	50.5	52.8	56.6	60.8	61.8
(6)	9.3	9.9	10.3	10.8	11.3	11.8	12.3	12.9	13.4	14.1
	9.9	10.5	11.0	11.5	12.1	12.7	13.4	14.0	14.7	15.4
(7)	11.9	12.9	13.9	14.8	15.8	16.8	17.9	19.2	20.6	21.8
	15.0	16.2	17.4	18.6	19.9	21.1	22.5	24.1	25.8	27.4
(8)	**−2.6**	**−4.2**	**−7.2**	**−5.0**	**−4.4**	**−6.7**	**−8.2**	**−11.1**	**−12.3**	**−12.7**
	14.5	**14.1**	**14.3**	**18.4**	**19.9**	**22.2**	**21.9**	**23.8**	**25.8**	**28.7**

Table 13
Soviet Machine Building and Metalworking: Lee's Estimate of Military Purchases

	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) MBMW gross value of output [a]	60.5	68.1	76.6	85.1	NA	NA	NA	NA	NA
(2) Metalworking and repair [b]	12.5	13.7	15.3	16.8	NA	NA	NA	NA	NA
(3) Machine-building gross value of output [c]	48.0	54.4	61.3	68.3	75.9	85.0	94.9	107.0	119.9
(4) Final demand ratio [d]	0.602 0.622	0.602 0.622	0.602 0.622	0.602 0.622	0.600 0.620	0.600 0.620	0.600 0.620	0.600 0.620	0.600 0.620
(5) Machine-building deliveries to final demand [e]	28.9 29.9	32.7 33.8	36.9 38.1	41.1 42.5	46.3 46.3	51.8 51.8	57.8 57.8	65.2 65.2	73.1 73.1
(6) Net machinery imports [f]	0.4 0.4	0.6 0.6	0.7 0.7	0.8 0.8	0.8 2.4	0.6 2.2	0.9 2.9	1.1 3.4	1.1 3.7
(7) Producer durables [g]	19.1	20.4	22.0	23.5	25.3	26.6	28.8	31.1	34.1
(8) Consumer durables [h]	2.6 2.6	2.8 2.8	3.0 3.0	3.2 3.2	3.9 4.0	4.4 4.6	5.5 5.6	6.5 6.7	7.7 7.9
(9) Military purchases of machinery [i]	**7.6** **8.6**	**10.1** **11.2**	**12.6** **13.8**	**15.2** **16.6**	**17.8** **19.5**	**21.2** **23.0**	**24.3** **26.4**	**28.5** **31.0**	**32.2** **35.1**

[a] The data and footnotes for this table were prepared from William T. Lee, *The Estimation of Soviet Defense Expenditures, 1955-75: An Unconventional Approach* (New York: Praeger, 1977) for the years 1966-69 and from an annotated version of William T. Lee, *Trends in Soviet Defense Expenditures* (California: Analytical Assessments Corporation, December 1979) for 1970-80. Lee employs the labor force and wage method to derive MBMW GVO. (See appendix section "MBMW GVO" for an explanation.) In his earlier book, he calculates a value for 1970 and then expands to a time series in 1970 comparable prices using the MBMW growth index. Basically, the steps are similar to CIA's; however, three of the calculations differ. First, Lee uses industry average wages rather than estimating MBMW wages. Second, he estimates the social insurance deductions in MBMW as 7.7 percent of the wage bill in 1966-80, whereas CIA estimates the deductions at 7.2 percent. Finally, he does not subtract MBMW MIF payments from the wage bill. In *Trends*, Lee calculates only machine-building gross value of output for 1970-80 and does not present MBMW GVO.

[b] Unlike CIA and DIA, Lee removes all metalworking and repair from the residual. He uses the metalworking and repair values from the 1966 input-output table and expands to a time series in 1966 comparable prices by applying the metalworking and repair growth indexes published annually in the *Narkhoz*. The series is not moved to 1970 comparable prices.

[c] Row 1 minus row 2.

[d] Lee calculates the ratio of machine-building deliveries to final demand to machine-building GVO from data published in an early version of the 1966 input-output table. The low and high ratios, respectively, include and exclude the cable industry, which had negative final demand in early reconstructions of the input-output tables. (See Vladimir G. Treml, Barry L. Kostinsky, Kurt W. Kruger, and Dimitri M. Gallik, *Conversion of Soviet Input-Output Tables to Producers' Prices: The 1966 Reconstructed Table* [Washington, D. C.: US Department of Commerce, Bureau of Economic Analysis, July 1973], p. 68.) Later reconstructions, however, list cable products final demand as a positive value. (See Gallik, Kostinsky, and Treml, *Input-Output Structure*, p. 76). In addition, Lee has not updated his ratio to incorporate data in the 1972 and 1977 input-output tables, which indicate a downward trend in the ratio. Rather, he uses the 1966 ratios—rounded to 0.60 and 0.62 in his later publication—for every year in his series.

[e] Row 3 times row 4. Lee uses the midpoint of the resulting estimate, rather than the range.

Table 13 (continued)

Billion 1970 comparable rubles
(unless otherwise noted)

	1975	1976	1977	1978	1979	1980
(1)	NA	NA	NA	NA	NA	NA
(2)	NA	NA	NA	NA	NA	NA
(3)	134.3	148.0	161.7	177.0	191.5	203.3
(4)	0.600	0.600	0.600	0.600	0.600	0.600
	0.620	0.620	0.620	0.620	0.620	0.620
(5)	82.0	90.3	98.6	108.0	116.7	124.0
	82.0	90.3	98.6	108.0	116.7	124.0
(6)	3.4	4.0	3.8	8.2	8.5	8.0
	7.2	8.5	8.7	15.5	16.1	15.5
(7)	38.5	42.2	44.6	48.3	50.1	52.1
(8)	9.4	10.5	11.7	13.2	14.5	16.1
	9.7	10.8	12.1	13.6	15.0	16.6
(9)	**37.2**	**41.3**	**45.1**	**54.3**	**59.6**	**63.3**
	41.5	**46.1**	**51.0**	**62.0**	**67.7**	**73.3**

[f] Lee's estimate of net machinery imports through 1977 is based on the machinery and equipment trade data reported annually in Soviet statistical handbooks (which provide the same data as the *Narkhoz*). The overall trade residuals are not included. Lee adjusts to domestic prices using the 1966 coefficient of 0.71. However, he leaves the series in current purchasers' prices rather than converting to 1970 comparable producers' prices. For 1977-80 he estimates machinery imports and exports by extrapolating at the growth rate for 1970-77.

[g] For the producer durables series for 1966-69, Lee and CIA include the same three components. Some adjustments differ, however. Lee does not allow for a time lag between the production and reporting of investment machinery. In addition, since only scattered information is available on changes in uninstalled equipment and purchases by budget-supported institutions, Lee extrapolates. He does not, however, include a range of uncertainty. Lee adjusts his producer durables to producers' prices by deducting 5 percent of the total value. He does not believe that any non-MBMW goods are included in the investment data, as CIA and DIA do. Lee's 1970-77 producer durables estimates include only the *Narkhoz* data on new fixed investment, while his 1978-80 figures are based on planned 10th Five-Year Plan capital investment growth.

[h] Lee's consumer durables series is based on machine-building consumer durables data published in the *Narkhoz* during the 1960s. He converts these data from purchasers' to producers' prices and then extrapolates to 1971. For 1970-80, Lee—like DIA—uses *Narkhoz* data on the production of machinery for consumption.

[i] Row 5 plus row 6, minus rows 7 and 8.

Table 14
Soviet Machine Building and Metalworking: DIA's Estimate of Military Purchases

Billion current rubles (unless otherwise noted)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
(1) MBMW gross value of output [a]	86.4	92.9	106.4	113.4	123.3	130.6	138.3	147.2	158.5	170.4	180.4
(2) Final demand ratio [b]	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
(3) MBMW deliveries to final demand [c]	46.7	50.2	57.5	61.2	66.6	70.5	74.7	79.5	85.6	92.0	97.4
	51.0	54.8	62.8	66.9	72.7	77.1	81.6	86.6	93.5	100.6	106.4
(4) Net machinery imports [d]	0	0	0.5	0.2	0.3	2.4	2.6	1.9	3.7	2.9	3.5
(5) Producer durables [e]	22.0	23.1	25.0	26.9	29.6	33.4	36.6	38.7	41.9	43.5	45.2
(6) Common-use durables [f]	0.4	0.4	0.5	0.6	0.7	0.9	0.9	0.9	1.0	1.1	1.2
	1.0	1.0	1.2	1.3	1.4	1.6	1.6	1.7	1.8	1.9	2.0
(7) Consumer durables [g]	6.6	7.2	7.9	8.6	9.3	9.9	10.5	11.0	11.5	12.1	12.7
(8) Capital repair of civilian machinery [h]	5.9	6.5	7.2	7.4	7.8	8.0	8.2	8.4	8.7	9.1	9.3
	6.2	6.7	7.2	7.7	8.3	9.4	10.0	10.7	11.4	12.3	14.5
(9) Military purchases of machinery [i]	**12.4**	**13.6**	**18.0**	**18.1**	**19.2**	**20.6**	**20.9**	**21.4**	**24.6**	**27.2**	**29.7**
	17.6	**19.1**	**24.0**	**24.8**	**26.5**	**28.7**	**29.7**	**30.9**	**35.3**	**38.9**	**42.5**

[a] DIA derives an MBMW GVO series from amortization data published annually in the *Narkhoz*. (See figure 14 for the estimating steps.) The figures DIA estimates are not strictly in current prices because the Soviets reported industry capital stock (to which the amortization rates are applied) in 1955 comparable prices for 1970-72, in current prices for 1973-74, and in 1973 comparable prices after 1974. In addition, amortization rates have not been published since 1977. Slight errors in the estimation of these rates after 1977 result in large errors in MBMW GVO.

[b] DIA relies on the 1966 and 1972 input-output tables for the ratios of MBMW final demand to MBMW GVO. DIA's ratio is ranged between the two ratios from the tables—0.59 and 0.54—for the 1970-80 period.

[c] Row 1 times row 2.

[d] DIA includes both explicitly reported foreign trade in machinery and equipment and a portion of the overall trade residuals in the estimate of net machinery imports. It assumes that 70 percent of the residual includes machinery trade.

[e] To estimate the machinery component of producer durables, DIA uses reported data on the machinery and equipment component of investment, but assumes that no timelag exists between production of machinery and the reporting of it as investment. Five percent of the total is removed to account for the non-MBMW goods probably included in the data, and an additional 5 percent is deducted to convert from estimate to producers' prices. DIA assumes that the series in 1969 and 1973 comparable prices represent current prices.

[f] DIA believes that the military procurement of common-use durables may be reported under producer durables. To indicate this possibility, DIA adds what it considers to be a conservative estimate of military purchases of common-use durables (this row) to its estimates of military machinery purchases.

[g] DIA extracts a machinery consumer durables value from the 1972 input-output table. To derive a time series, the 1972 value is multiplied by an index of the production of machinery for consumption reported in the *Narkhoz*. For 1970 and 1975-80, the index is based on current prices, while for 1971-74, the index is based on 1967 comparable prices. Thus, the resulting series is not entirely in current prices.

[h] DIA retains military-related capital repair in the residual. It multiplies the capital repair value published in the 1972 input-output table by two growth indexes to develop a range of estimates for 1970-80. The first index is constructed by calculating the share of capital repair to total MBMW GVO in 1966 and 1972, and interpolating and extrapolating for the remaining years. The second index is based on the capital repair figures of 6.7 billion rubles in the 1966 input-output table and 10.3 billion rubles in the 1972 input-output table. The trends are interpolated and extrapolated. To estimate the civilian share of capital repair, DIA uses the approach described in table 10, row 7. By assuming that the ratio of the residual to total MBMW final demand is similar to the ratio of capital repair to total repair, DIA estimates that 70 percent of capital repair is civilian-related purchases.

[i] Rows 3, 4, and 6 minus rows 5, 7, and 8.

Notes

[1] Other residual approaches, such as those which examine Soviet budgetary data and national economic balance tables, are not examined in this study.

[2] William T. Lee, *The Estimation of Soviet Defense Expenditures, 1955-75: An Unconventional Approach* (New York: Praeger, 1977). Lee is now employed by DIA; this paper presents his work and that of DIA before his employment with that agency.

[3] Vladimir G. Treml, Barry L. Kostinsky, and Dimitri M. Gallik, "1966 Ex Post Input-Output Tables for the USSR: A Survey," *Studies in Soviet Input-Output Analysis*, ed. V. Treml (New York: Praeger, 1977), pp. 47, 49; Dimitri M. Gallik, Barry L. Kostinsky, and Vladimir G. Treml, *Input-Output Structure of the Soviet Economy* (Washington, D.C.: US Department of Commerce, Bureau of Economic Analysis, April 1983), p. 76; and Dimitri M. Gallik, Meredith Heinemeier, Barry L. Kostinsky, Vladimir G. Treml, and Albina Tretyakova, *Construction of a 1977 Soviet Input-Output Table* (Washington, D.C.: US Department of Commerce, Bureau of the Census, January 1984), p. 8.

[4] We use the terminology adopted by most residual analysts of labeling MBMW deliveries to final demand by the class of user rather than type of use. Thus, we refer to the MBMW component of investment as producer durables and to private and public consumption of machinery as consumer durables.

[5] Capital repairs, in contrast to routine maintenance, are major repairs that extend the working life of the machinery, such as the replacement of a truck engine. (U)

[6] Military durables may be maintained better than civilian durables, but they are generally operated less. We assume that the additional annual cost for capital repair caused by better maintenance is offset by the savings resulting from less operation.

[7] Values in current prices measure actual expenditures. Values in comparable prices are supposed to be in constant or deflated prices. The manner in which comparable prices are calculated, however, results in price and growth indexes that overstate real growth of output and understate inflation. See the section on "Current and Comparable Prices."

[8] We calculate growth rates by determining the annual percentage changes in the data and then taking the arithmetic mean of those changes. The resulting average annual rates of growth are slightly higher than the compound annual growth rate would be. We prefer the annual change method because it takes into account all of the data rather than just the values for the first and last years.

[9] Lee has reported estimates for procurement of 86 billion rubles and 100 billion rubles for 1983 and 1985, respectively, in "Meeting Report" (Washington, D.C.: The Wilson Center, Kennan Institute for Advanced Russian Studies), 16 October 1985.

[10] Soviet price indexes indicate deflation in MBMW prices. Thus, an MBMW output series measured in 1970 comparable prices is higher than the same series in current prices after 1970 and lower before 1970. As a result, a current-price series of MBMW output grows less rapidly than a comparable-price series.

See James Steiner, *Inflation in Soviet Industry and Machine-Building and Metalworking (MBMW) 1960-1975* (CIA, Office of Strategic Research, 1978); Fyodor I. Kushnirsky, *Price Inflation in the Soviet Machine-Building and Metalworking Sector* (Philadelphia: Temple University, January 1983); and Fyodor I. Kushnirsky, *Estimation of Real Growth and Productivity in the Soviet Machine-Building and Metalworking Sector* (Falls Church, Virginia: January 1986)

[11] As suggested by Kushnirsky in *Price Inflation*, another source of hidden inflation may be the declining quality of goods already in production.

[12] Vladimir G. Treml, Dimitri M. Gallik, Barry L. Kostinsky, and Kurt W. Kruger, *The Structure of the Soviet Economy* (New York: Praeger, pp. 123-45, 171-81, and Treml, Kostinsky, and Gallik, "1966," pp. 47-49.

[13] Dmitri Steinberg, *USSR National Economic Balance Tables: Estimating Soviet Military Expenditures for 1965, 1970-83* (Washington, D.C.: Department of Defense, Office of Net Assessment, working paper, March 1986).

[14] We estimate military machinery purchases in current prices and then convert them to 1970 comparable prices using the published MBMW wholesale price index. We do this in order to compare our results with those of William Lee; however, we do not believe that the price index is a valid measure of inflation in military machinery prices.

[15] United Nations, *Yearbook of Industrial Statistics, 1975 Edition* (New York: 1977), p. 589; United Nations, *Industrial Statistics Yearbook 1982;* Vol. 1 (New York: 1985), p. 590; and *Vestnik statistiki*, No. 2 (Moscow: 1986), p. 77.

[16] In 1976, a Soviet economist reported that incentive payments for engineers and technical workers were 25 to 30 percent of wages. See U. A. Artemov, *Voprosi ekonomiki*, No. 8 (Moscow: 1975), p. 38.

[17] Former Soviet Premier N. Tikhonov, in his 1981 CPSU Congress Report, said that MBMW GVO was 180 billion rubles in 1980. Since he was speaking about the 1981-85 Five-Year Plan, his statement may have referred to 1975 comparable prices, the standard price measure in the Soviet Union at that time. If our 1980 MBMW GVO estimate is converted to 1975 comparable prices, the resulting figure is 182 to 196 billion rubles. This also suggests that actual establishment-based MBMW GVO may be at the low end of our estimated range. Alternatively, the Tikhonov figure may reflect a different base—the prices used in the compilation of the 1981-85 Plan.

[19] See, for example, L. M. Kantora and A. G. Zavyalkova, *Izderdzhki proizvodstva* (Minsk: 1974), p. 77. (

[20] We would expect to see the ratio decline over time. As machinery becomes more complex, more subcomponents are used in its production, and hence the share of total production devoted to final demand products decreases. This is evidenced by the trend in the machinery final demand ratio for the United States. The ratio declined from 0.42 in 1976 to 0.38 in 1982. See also, A. M. Volkov in V. K. Senchagov, ed. *Finansoviye resursy narodnogo khozyaystvo* (Moscow: *Statistika*, 1982), p. 68. According to Volkov, a prominent input-output specialist in the Soviet Union, "the share of intrabranch turnover in machine building is continuously increasing (from 31.8 percent in 1959, to 47.7 percent in 1966, to 54.7 percent in 1972). In 1977 the share also increased." The data refer to intraindustry sales, the value of machinery sold to machinery sectors only. It is less than interindustry sales (total intermediate use) by the value of sales to nonmachinery sectors. Since intraindustry machinery sales make up a large portion of interindustry sales and since the shares cited have increased so dramatically, this statement supports the input-output data, which indicate that the ratio of MBMW output for intermediate use to MBMW GVO has been continuously increasing, at least through 1977 (and, conversely, the final demand ratio has been falling).

[21] Final demand ratios will vary from one methodology to another, depending on whether capital repair and/or metalworking are included in the calculation of the ratio. The trend is not significantly altered by these differences, however. (

[22] Lee cites a Soviet economist who, he claims, stated that the final demand ratio has been increasing. We do not agree with his interpretation of that evidence. See V. Ivanchenko, "Criterii effektivnosti i kachestva," *Voprosi ekonomiki*, No. 7 (Moscow: 1978), pp. 33-43.

[23] See Barry L. Kostinsky, *Description and Analysis of Soviet Foreign Trade Statistics* (Washington, D.C.: US Department of Commerce, Bureau of Economic Analysis, July 1974), pp. 46-56, 69. (

[24] Philip Hanson, *Trade and Technology in Soviet-Western Relations* (New York: Columbia University Press, 1981), pp. 124-25

[25] About the only set of data that apparently does not have to be adjusted for commodity-establishment differentials is foreign trade data. Machinery imports, since they are produced outside the Soviet Union, need not be adjusted. We assume that machinery exports on a commodity basis and on an establishment basis are equivalent.

[26] For further discussion of the difference between current and comparable prices for investment data, see Philip Hanson, "The CIA, the TsSU, and the Real Growth of Soviet Investment," *Soviet Studies*, Vol. 36, No. 4 (Glasgow: University of Glasgow, October 1984), pp. 571-81, and Abraham Becker, *Soviet National Income, 1958-1964* (Berkeley and Los Angeles: University of California Press, 1969), pp. 513-16.

[27] See Michael Boretsky, "The Technical Base of Soviet Military Power," *Economic Performance and the Military Burden in the Soviet Union* (Washington, D.C.: Joint Economic Committee, 1970), p. 229. (

[28] V. M. Rutgayzer, *Resursy razvitiya neproizvodstvennoy sfery* (Moscow: Mysl', 1975), p. 168.

[29] If significant amounts of machinery delivered to public consumption are purchased by the military for other than military R&D institutions, our estimate of military consumer durables is biased downward. In contrast, equipment purchases reported as a component of material inputs to science may reflect some purchases by budget-supported R&D institutions. Because we attempt to remove purchases by budget-supported institutes in our calculation of producer durables, we may be biasing our estimate of military consumer durables upward.

[30] Current repair—included under intermediate use output in input-output tables—is a current operating expense. Capital repair, in contrast, is repair work on machinery that increases its asset value. Therefore, capital repair is considered an investment and included as final demand output in the input-output tables.

[31] Capital repair values of 6.7 billion and 10.1 billion rubles for 1966 and 1972, respectively, were reported in the input-output tables. The 1967 value lies in the middle of the range of our establishment-based estimate, while the 1972 figure is slightly lower than our low estimate. The differences may result from comparing commodity and establishment data. (C NF)

[32] *The Growth of Capital Repair in the USSR, 1950-1977* (C, A unpublished working paper, March 1979.) (U)

[33] M. R. Eydel'man, *Mezhotraslevoy balans obshchestvennogo produkta* (Moscow: Izdatel'stvo Statistika, 1966). (

[34] *Growth* p. 53.

[35] Capital repair expenditures are more closely related to capital stock than to annual machinery purchases. Because of the lack of stock data, however, we must rely on annual purchases.

[36] When subtracting repair, Lee, although not stating his reason, also removes all metalworking from his residual. CIA retains purchases of final-use metalworking in the residual. Approximately 30 percent of total metalworking GVO is delivered to final demand. In addition, some of this final demand is reported in the input-output tables as consumer durables. Thus, when the military purchases machinery consumer durables, some metalworking may be included in the form of machinery such as doors and metal fixtures. The same may hold true for producer durables. Because we are attempting to estimate all military purchases of MBMW output, we include an estimate of military purchases of final demand metalworking in the residual.

Glossary

MBMW GVO	Gross value of the output (GVO) of the machine-building and metalworking (MBMW) industries in the Soviet Union. It includes the value of finished MBMW output ready for sale, MBMW output that will be used further in the production of other items, and repair work.
MBMW intermediate products	Machinery output sold to other producing enterprises for further processing or to be used in current repair.
MBMW deliveries to final demand	MBMW GVO minus MBMW intermediate products. It represents all machinery available for sale to final end uses—consumption, investment, defense, and foreign trade.
Net machinery imports	Total machinery imports minus total machinery exports.
Producer durables	The machinery and equipment component of investment that is purchased by production enterprises, purchases by budget-supported institutions, and changes in the stocks of uninstalled equipment at construction sites.
Consumer durables	The machinery purchased by individuals for private use or by public institutions serving the population.
Capital repair	Repair work on machinery that increases its asset value and is therefore counted in the investment part of Soviet national income.
Military machinery purchases residual	Purchases of military machinery estimated by subtracting identifiable nondefense purchases from MBMW deliveries to final demand in the Soviet economy.
Defense procurement	Annual cost of procuring new weapons and equipment and their initial spare parts for the military.
Current prices	Prices attached to machinery output in a given year.
Comparable prices	Prices which represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, include considerable inflation.
Producers' prices	Prices charged by the enterprise at the factory gate.

Purchasers' prices	Producers' prices plus transportation and distribution charges, taxes, and customs duties.
Foreign trade prices	Prices at which Soviet goods are bought and sold in foreign trade. They are set by Soviet planners in a process separate from the establishment of domestic prices and fluctuate as world market conditions change.
Estimate prices	Fixed prices used by the Soviets in planning investment.
Establishment-based data	Data that represent the output of all enterprises that primarily produce machinery and metal articles and/or repair machinery. Output reported in this manner does not include machinery produced as a secondary product in non-MBMW enterprises.
Commodity-based data	Data that represent the total output of machinery, regardless of where it is produced. Machinery produced outside of MBMW industries is included and nonmachinery output of MBMW enterprises is not included.